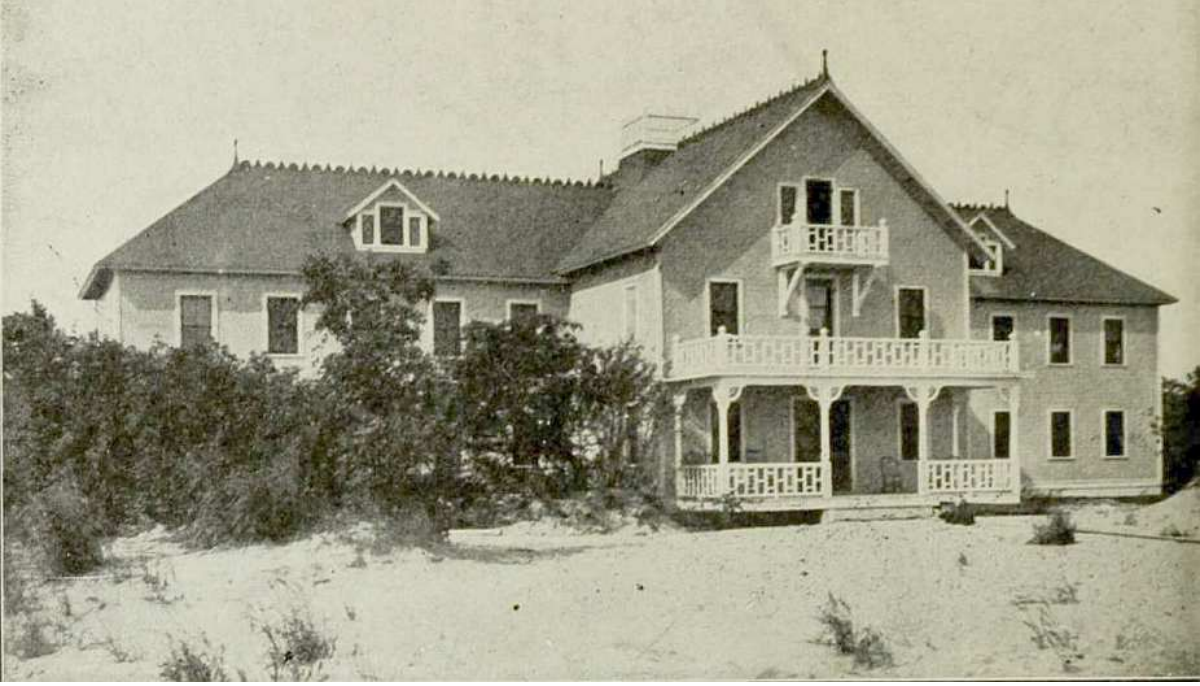

[photo of the "LAKE LABORATORY" on Cedar Point (peninsula/island), circa-1904]

[**"Cedar Point" section begins on pdf-page '33'** (orig.-pg. "210").]

[See also the section about Cedar Point's "Black Channel" on orig.pg. "205", and etc.]

[A brief history of the "Lake Laboratory" is appended to the final page, here.]

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[IMPORTANT NOTE (2021): *" CEDAR POINT IS THE PENINSULA "* as per page "210".
(However, after 1969, it technically became an '**island**' due to erosion of its far easterly end.)]

PRESIDENT'S ADDRESS

Formation of Sandusky Bay and Cedar Point

E. L. MOSELEY

NORTHEAST GALES.

No wonder people talk about the weather! What else affects the fortunes of men so much? The night of June 28th, 1902, having decided to take an early train for Pittsburg and so not sleeping as well as usual, I listened to the rain beating against my east windows. Walking with rubber boots to the depot I found gutters overflowing, all the ditches between Sandusky and Cleveland carrying torrents of muddy water, and creeks swollen to the size of small rivers bearing on the load of sediment toward the bay and lake.

Others too had reason to remember that northeast storm. The water in the bay rose higher than for fifteen years before. Along the southwestern shore several acres of land were washed away. In Sandusky thousands of feet of lumber were washed off the docks. No boat ventured out of the bay.

In the lake, the steamer Dunbar foundered southeast of Middle Island. Of the ten on board five took to the life raft and five to a yawl boat. The boat capsized and two of its occupants drowned. "The others, Captain Little, his wife, and daughter supported by life-preservers drifted about for several hours until they were borne to the vicinity of Kelley's Island," where they were rescued by the heroic efforts of Fred Dishinger, Sr., Fred Dishinger, Jr., and James Hamilton. The next morning, a corpse was found on the beach less than two miles west of Huron and a little farther west, on Cedar Point close to Rye Beach, two more with a life raft bearing the word "Dunbar." On one was a watch still running and keeping nearly correct Eastern time!

On the east point of South Bass Island the waves piled up the gravel into a ridge which remains to this day. Along the east side of the Marblehead Sand Spit at the entrance to Sandusky Bay is a ridge supporting a growth of young willows and cottonwoods. It was probably formed at the same time.

"Not only is it true that the work accomplished in a few days during the height of the chief flood of the year is greater than all that is accomplished during the remainder of the year, but it may even be true that the effect of the maximum flood of

the decade or generation or century surpasses the combined effect of all minor floods. In littoral transportation the great storm bears the same relation to the minor storm and to the fair weather breeze. The waves created by the great storm not only lift more detritus from each unit of the littoral zone, but they act upon a broader zone, and they are competent to move larger masses. The currents which accompany them are correspondingly rapid and carry forward the augmented shore drift at an accelerated rate."—Gilbert.

The greatest storms of the past century or those which were most effective because occurring at time of highest water were those of 1857–1862.

The water covered the land where the Sandusky Tool Factory stands and the street adjacent so that the workmen went to the building, then a saw mill, in row boats. It flooded the cellars on the south side of Railroad Street. The part of the city near the end of First Street and east of it was under water. These storms damaged the bridge across Sandusky Bay and the railroad near Port Clinton. Along miles and miles of shore and over hundreds of acres of lowland they killed trees that had stood for centuries. They cut away large slices of Eagle Island at the head of the bay and the last remnant of Spit Island at the mouth of the bay. They cut through the land west of Port Clinton giving an outlet for the Portage River about one-fourth mile farther west than before, but the breach was afterwards closed by the L. S. & M. S. R. R. Co. They built up on the northeast shore of Cedar Point long sand ridges twelve feet high on which hundreds of cottonwoods have since grown to a height of fifty or sixty feet.

The preceding statements may suffice to illustrate the sort of changes effected by northeast gales but those who have seen Lake Erie only when it is calm or stirred by winds of moderate force will be further impressed with its power by a brief notice of particular storms which are remembered by old residents or noted in the journal of the weather observer.

The northeast storms of 1857-1862 are said to have been more frequent and usually of longer duration than those of late years. Regarding this point a number of old residents agree and they are probably not mistaken, for the records of rainfall at the stations in this part of the country where records were kept so early show that the precipitation of 1857 and 1858 has not been equalled since.

Captain Freyensee and Mr. Haas, then in charge of the Swan, are sure that the water became exceedingly high in August, 1857, during a thunderstorm accompanied by a violent

wind from the northeast. They think this was the highest water ever seen at Sandusky. It was, however, of short duration, coming up early in the afternoon and falling during the night.

Captain Magle, then in command of the schooner H. C. Post, recalls a storm August 11, 1859, as occasioning the highest water he ever saw in Sandusky Bay.

Several persons have told me of a great storm in August, 1861. Northeast gales may have been more violent at other times, but this one coming when the water was already high and lasting several days was probably in its effect the greatest storm of the century. East of where the water works are now located it lifted the railroad track from its bed, and pushed it, in places, twenty feet away. At the foot of Columbus Avenue the dock was about a foot lower than now and did not extend so far north. A track then ran onto the dock from a turn-table south of it. In this storm water covered the dock and a great sea struck two empty cars that had been standing there with such force as to move them along the track and cause them to fall into the tu n-pit.

This storm washed away the steamer dock at Kelley's Island. The water went over the dock at Put-in-Bay, so that no landing could be made. The water has probably never reached so high a stage since.

Allan Winters recalls a northeaster in the spring of 1860, a greater one in the spring of 1861, but the greatest of all that of August, 1861.

Captain Haas remembers a great northeaster in 1862. There appear to have been none especially memorable in the spring of 1859 but the water was then so high that northeast gales not regarded at the time as extraordinary produced changes in the shores of considerable importance.

The Sandusky station of the U. S. Weather Bureau was established in 1877. In the next few years several northeast storms occurred more violent than any in recent years.

September 11, 1878, a gale began at five A. M. continuing until 5:45 P. M., Sept. 13, direction northeast and north backing to northwest in the afternoon of the 13th. Maximum velocity Sept. 11, thirty-four miles northeast; Sept. 12, forty-eight miles northeast; Sept. 13, fourty-four miles northeast. Total wind movement in twenty-four hours ending at noon Sept. 13, nine hundred and one miles. Unusually heavy rain on night of the 12th. Twenty-seven steamers, "Among them the largest propellers on the lake" and sailing vessels anchored behind Kelley's Island.

July 11, 1879, a gale began at 10:15 A. M. and ended at 3:10 P. M. both direction and velocity quite variable. A lull from

2:40 to 2:45 was followed by "a storm of wind and rain whose fury was almost indescribable, though fortunately of short duration, the wind reaching a velocity of sixty-nine miles from the north while the rain came down in such a deluge that one could not see two feet from the window, the thunder and lightning being appalling. The wind for ten minutes or from 2:45 P. M. to 2:55 P. M. reached and maintained a velocity of seventy-two miles per hour. At least 2.25 inches of rain fell during the fifteen minutes that the storm raged so violently. Heavy seas were dashed over railroad cars standing at least fifty feet from the water. At least one hundred chimneys were blown down."—From journal of Sandusky Weather Bureau Office. Some of these statements may be exaggerated as others in the journal, but not quoted, certainly are.

August 15, 1879, a severe northeast gale set in at 12:30 P. M., the velocity ranging from thirty to forty miles that day, but from midnight till six A. M., August 16, averaging forty-eight miles and attaining a maximum of fifty-nine miles at 3:30 A. M. In the afternoon of August 16, the direction was north and the gale ended with a velocity of twenty-five miles at 5:10 P. M. It caused very high seas and damaged several boats in the lake, no vessels of any kind entered or left the bay after the storm began. The total wind movement in twenty-four hours ending at noon August 16th, was nine hundred and fourteen miles. This and the average of forty-eight miles per hour for six hours are, I believe, unsurpassed in the records of the Sandusky office, while the maximum of fifty-nine miles has been surpassed but three times, viz., in the brief storm of July 11th, already mentioned; in a squall, August 9, 1885, sixty-three miles, northeast; and the following:

Jan. 31, 1881, a gale from the northeast began at 7:30 A. M., reaching its height, sixty-four miles northeast, at 9:35 A. M., Feb. 1st, and ending at 5:30 P. M. "The storm was one of the most severe known in these parts, the wind average forty-two miles per hour for eighteen hours; no extensive damage done." The water that winter was too low to be raised to an extraordinary height even by such a gale.

The highest water in Sandusky Bay since 1862 occurred April 23, 1882. The northeast gale began at 10:15 A. M. April 22, and continued till 4:30 P. M. April 23, the maximum, forty-four miles, occurring at 2:15 A. M. It averaged 32 5-12 miles per hour for twenty-four hours. The bay flooded everything on Railroad Street from one end to the other. At Marblehead a dock was washed away and three others damaged. The schooner Gallatin was wrecked about two miles from Pelee Island. Thirty vessels took shelter behind Kelley's Island.

The effect of some of these same storms in producing lasting changes on Cedar Point and elsewhere about the bay will be mentioned in subsequent chapters. Storms of much less violence than these seem awful to those who are on the lake at the time. On May 31st, 1903, the water striking the Ohlemacher dock on Marblehead was dashed so high that people at a distance could see it over the tops of the limekilns and on another occasion Alex R. Clemons estimates that the spray went more than fifty feet above the top of this high dock. In front of the large stone house which stands near the lake in Marblehead village a piece of limestone estimated to weigh two and one-half tons was broken loose from the bed rock and moved along shore twenty-seven feet by a single storm. Looking from this place Mr. Clemons has counted as many as seven wrecks, all in sight at one time.

EFFECT OF TILTING OF THE LAND.

LAKE BEACHES.

When the glacier had retreated beyond the northern boundary of Ohio a lake extended along the southern border of the ice. The south shore of this lake was at first about twenty miles south of where Sandusky now is. Its western extremity was at Fort Wayne, Indiana, whence the water flowed to Huntington and via the Wabash and Mississippi to the gulf. As the ice melted from the southern part of Michigan, outlets were formed into the Grand River valley through which the water flowed to another glacial lake occupying the southern part of the basin of Lake Michigan and thence toward the Mississippi through the depression now utilized for the Chicago drainage canal. The later outlets were lower than the earlier ones and consequently the lake level fell and each time it fell its southern shore came nearer Sandusky. Each position of the shore is marked by a beach. The highest beach extends from Fort Wayne through Van Wert, Tiffin, Pontiac, the southern part of Norwalk and Berlin Heights, from there on east continuing only a few miles from Lake Erie. The middle beach extends through Bellevue, Monroeville, the main street of Norwalk, Berlin Heights and Elyria. The lowest beach passes through Clyde, south of Milan through Berlin Heights and along Euclid Avenue, Cleveland, through northwestern Pennsylvania and western New York.

Each beach, when formed, must have been approximately level as it followed the shore of a lake. But they are no longer level. Leverett has found that the lowest one is 168 feet higher at Crittenden, N. Y., than at Cleveland, showing that the land between these places has been tilted to that extent. Old beaches

near the other Great Lakes indicate that the whole region has undergone tilting.

GILBERT'S RESEARCHES.

Whether this tilting is still going on or ceased long ago does not appear from an examination of these old beaches. In 1895 Mr. G. K. Gilbert found evidence that it was still continuing. By comparing the heights above the normal lake level of a bench-mark in Cleveland and one at the head of the Welland Canal with the heights of the same as carefully determined in 1858, it appeared that the land near the northeast end of the lake had risen as compared with Cleveland. In like manner he found that tilting was still going on in the region of Lake Ontario and Lake Huron and Michigan.

DEEPENING OF THE WATER.

Inasmuch as the tilting produces a rise of the land toward the northeast as compared with that toward the southwest it is elevating the point of outlet of Lake Erie as compared with the rest of the lake. As the lake is continually receiving water through the Detroit River and other sources the elevation of the point of outflow raises the level of the water throughout the entire basin.

In 1860, H. A. Winters now living in Sandusky, had occasion to visit Eagle Island many times. In a pond too deep for hip boots, but which he crossed with his boat, was a walnut stump whose sapwood had rotted away. The heartwood about four feet in diameter was still well preserved and showed that it had been neatly chopped off. Alvin Fox told him that he had helped to chop the tree in 1828, when the land about it was all dry. Through the summer of 1860 the stump stood in about two feet of water.

According to J. W. Lockwood, who lives on the north side of Sandusky Bay near the Plaster Beds, a man named Craighill cut an oak supposed to be two hundred or three hundred years old about 1823 or 1824 on what was then a dry prairie but where there has been a marsh ever since. This marsh borders what is known as West Harbor in the peninsula north of Sandusky Bay.

These observations and many others made it clear that the water had deepened but in view of the fluctuations produced by rainfall and the lack of early records of rainfall they did not afford a means of calculating with any degree of accuracy how fast the deepening would progress if the rainfall remained uniform. Not until the fall of 1904 was any means discovered of making such a calculation. It came from studying the parallel ridges which traverse the terminal portion of the Cedar Point

peninsula. These have been built up by great northeast storms and the approximate age of each of the principal ones has been determined from the vegetation upon it. The older ones are lower than those formed in the past century. By dividing the difference in height between the highest aqueous deposits in two ridges by the number of centuries intervening between their formation I have obtained the average number of feet the water has risen each century. It is about 2.14. A detailed description of these ridges is given in the part of the paper dealing with Cedar Point.

EFFECT OF VARIATION IN THE RAINFALL.

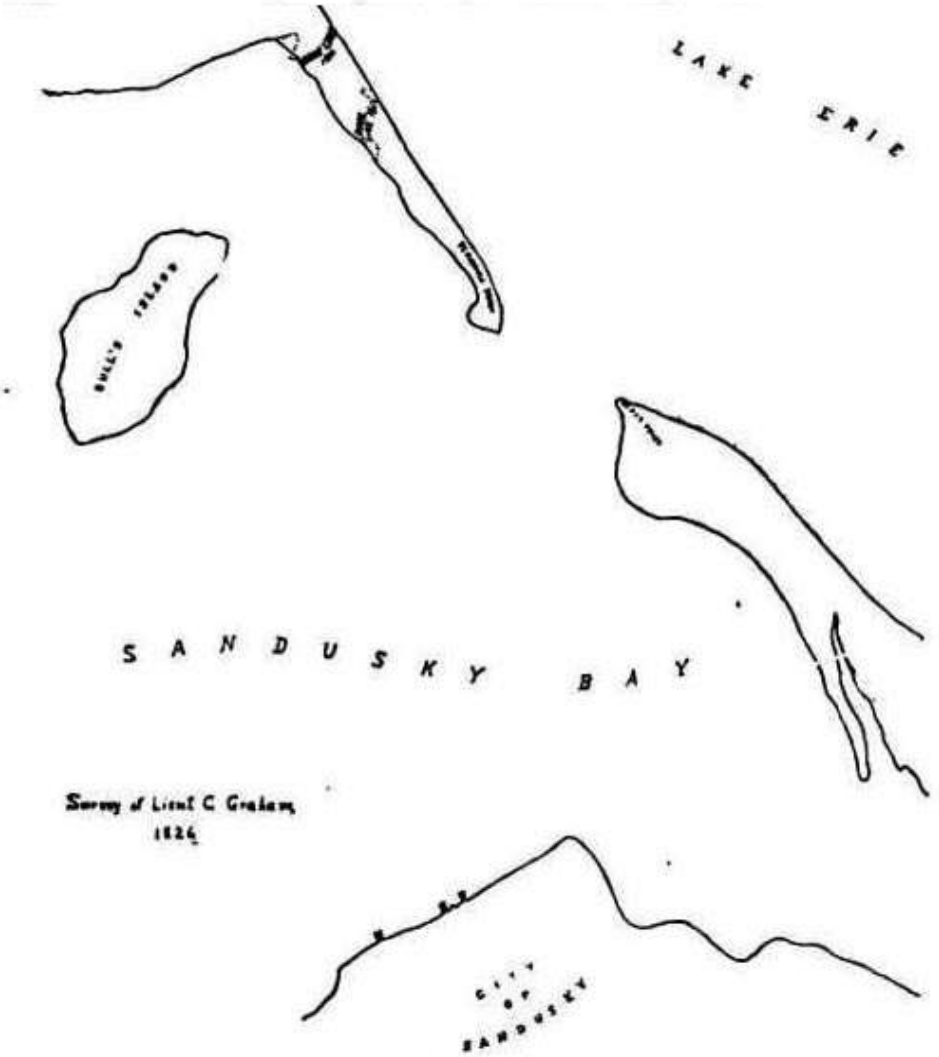
The deepening of the water produced by tilting of the lake basin has not been noticeable within the past half century because of greater fluctuations produced by variations in the rainfall. Those who recall the high water of 1858 to 1862 know that it has not been so high since. Moreover in 1894 and 1895 it was lower than they had ever seen it before, unless their observations began before the middle of the century. These facts seemed to disprove the theory that the water is gradually getting deeper. In an article in the National Geographic Magazine for August, 1903, I showed that, since 1870, when the Weather Bureau established stations about the Great Lakes, there has been a very close correspondence between rainfall and lake level. When the rainfall is above normal the lake rises, and when below normal it falls, whether we consider particular years, parts of years or periods of years. More recently I have learned that at the places in this part of the country where a record of rainfall was kept as early as 1857 the rain that year or the next was very heavy. Bulletin C., U. S. Weather Bureau, gives the rainfall of the United States from the earliest records to the end of 1891. In it are twenty-two places within one hundred miles of the Great Lakes that have a record for the year 1858. From data in this bulletin I have made the table, which includes besides these, St. Louis, Peoria and Marietta, although they are somewhat farther away. In fourteen of the twenty-five places the maximum rainfall for the whole period of record—in one instance seventy-one years—was in 1857 or 1858. In most of the other places the rainfall of 1857 or 1858 has been exceeded not more than three times. No wonder there was high water in 1858 with such precipitation as that. If the table were brought down to 1901, the years given above would still stand pre-eminent, for the rainfall from 1891 to 1901 was generally light—lighter in 1895 when the lake was also lowest than in any other year since the Weather Bureau was established.

Town	State	Years in record	No. of yrs. surpassing 1857 & '58	Maximum Rainfall	Year
St. Louis.....	Mo.	55	0	68.8	1858
Aurora.....	Ill...	16	0	47.4	1858
Ottawa.....	"	18	0	47.2	1858
Peoria.....	"	36	0	53.4	1858
Winnebago.....	"	14	0	45.2	1858
Marengo.....	"	39	1	56.9	1851
Janesville.....	Wis.	5	0	42.6	1858
Milwaukee.....	"	48	2	50.4	1876
Marquette.....	Mich.	29	5	42.9	1881
Grand Rapids....	"	11	2	51.9	1855
Bellefontaine....	Ohio	13	0	54.1	1858
Cleveland.....	"	36	4	53.6	1878
Marietta.....	"	71	0	61.9	1858
New Lisbon.....	"	10	1	47.1	1866
Steubenville.....	"	19	0	55.1	1857
Buffalo.....	N. Y.	34	9	60.3	1878
Cooperstown.....	"	38	1	58.1	1890
Geneva.....	"	25	0	42.6	1857
Hamilton.....	"	20	0	61.9	1857
Lowville.....	"	24	0	47.3	1857
Mexico.....	"	21	0	57.3	1857
Palermo.....	"	38	8	51.3	1859
Penn Yan.....	"	52	0	44.4	1857
Pierrepont Manor	"	21	3	50.7	1866
Rochester.....	"	57	3	48.7	1878

December 28, 1904, the wind having blown from the southwest all night with velocity between twenty and twenty-five miles an hour, the water in the bay was 4.1 feet below the zero of the gauge, which represents approximately the mean lake level from 1861-1895. Continuous gauge readings have not been kept at Sandusky except for short periods, but men whose business has been on the docks for more than twenty years said this was the lowest water they could remember. The high water in the northeaster of June 29, 1902, which was the highest for fifteen and perhaps for twenty years, is said to have reached nearly to the top of H. C. Post and Company's dock. December 28, 1904, I found the water seven feet, eight inches below the top of this dock, so that the difference was not far from seven and a half feet. Only about half a foot of this was due to difference in the stage of water preceding the storms, about three feet to the southwest wind and the remainder to the northeast wind. The maximum wind velocity in the northeaster of June 29, 1902, was only thirty miles. In 1888 the anemometer of the U. S. Weather Bureau office at Sandusky was removed from the West House to the government building which is lower and not so near the bay, causing considerable decrease in the total wind movement registered, so a satisfactory comparison of wind velocity in the later and earlier storms cannot be made. In the great storm of April 23, 1882, the water was probably more than a foot and a half higher than on June 29, 1902. This I infer from information furnished by men at the docks. The record of gage readings at Cleveland shows the stage of water to have been about a foot and a half higher at the time of the earlier storm so that the wind effect may have been nearly as great in the later one.

Only once in several years is the water at Sandusky raised or lowered from its normal level so much as three feet by the wind, while a change of four feet must be very rare. At Cleveland the change of level due to the wind is generally less than a foot, while at each end of the lake in extreme cases it is six or seven feet.

The fluctuations in level of Lake Erie due to changes in the amount of water received and lost in a single year are never much more than two feet, and in some decades do not exceed two and a half feet.



MAP I.

LAND LOST IN A SINGLE CENTURY.

PENINSULA POINT.

Map I, taken from a U. S. Government Chart shows Peninsula Point as it was in 1826. The distance between it and Cedar Point was about 3,000 feet but the water off the end of Peninsula Point was so shallow that when lowered by drouth and wind the distance from point to point was much less. H. A. Lyman, the old lighthouse keeper, told me he had seen the water so low that he thought the distance across was only about 300 feet. The Indians used to swim their ponies across and B. F. Dwelle, who lived until 1902, and many others of the early settlers on the Marblehead peninsula crossed in the same way. Cattle raised on the peninsula were driven to market this way, but not after 1830.

Some of the sand dunes near the south end of Peninsula Point were nearly as high, Mr. Lyman said, as the highest on Cedar Point. Three other persons recall their height as twenty feet or considerably more. Along the west side was clay covered with black soil several inches deep. The trees were not willows and cottonwoods alone, as on Marblehead bar which has since formed farther west, but white oak 2½ feet in diameter, red oak, shell bark hickory, ash, elm, buttonwood, basswood and red cedar. Mr. Lyman wrote me: "quite as large timber on it as there is on Cedar Point, viz., sycamore and oak." At one time there was an orchard.

Before 1834 the lake had made an opening through the northern end, after which it was known as Spit Island. The government spent "$40,000" in trying to save it. A large boarding house was erected for the workmen who built a crib along the whole length of the lake side. But in spite of efforts to protect it from the waves, it was worn away at both ends and the last remnant disappeared in the high water of about 1860.

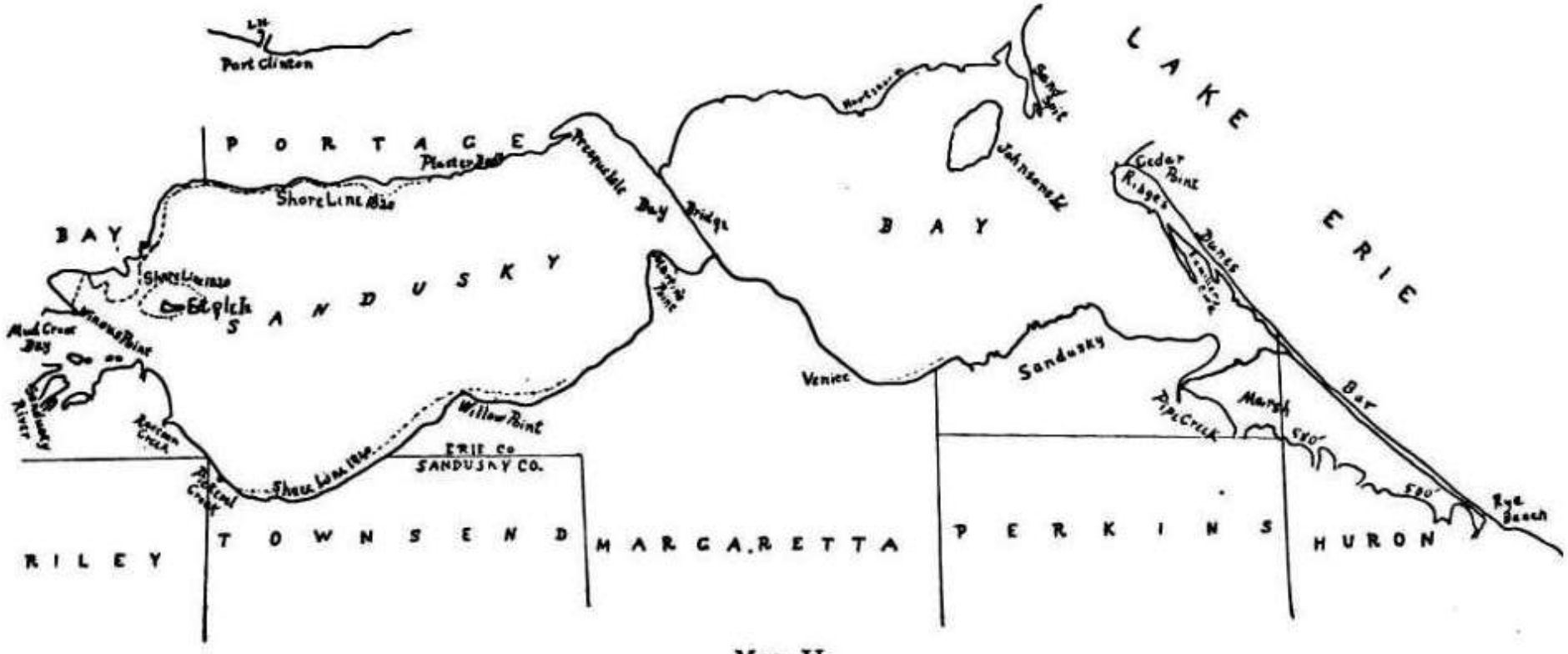
EAGLE ISLAND AND SQUAW ISLAND.

In 1820, when the first survey was made Eagle Island in the western part of the bay (see Map II) contained 134.42 acres.

There are now, 1904, two remnants which together contain less than two acres. The western one of these as seen from the Steamer Hayes Aug. 30, 1904, appeared to be entirely marsh. The island being located where the waves of the bay attain considerable force has suffered from every northeast storm, those of 1858–'62 dealing it some severe blows.

Miles Pearson told me that his mother, who was born in 1809, when a girl used to walk to the island from the south, crossing a channel on a plank, or in dry times stepping across. At that time the cattle used to go there to graze. Porter Wright told me that he walked to the Island and could have ridden a horse all the way; there was no danger of miring. He remembers when it had more than a hundred eagles' nests and it was unsafe, after the eaglets were out of the nests and on the ground, for a man to cross the island without carrying a club. Eagles' nests were also numerous on the neighboring mainland.

Squaw Island at the mouth of the Sandusky River, throughout the early part of the century was connected with the peninsula to the west, which was much wider than now. As late as 1855 it was separated merely by a channel for small boats. In 1873 the channel had widened to 230 feet, and in 1904 it was about 600 feet. It is said that the Indians used to swim their ponies from Peach Island to Squaw Island and then ride along the north bank of the river to Fremont.


Port Clinton
PORTAGE
Shore Line Rte
BAY
SANDUSKY
Mud Creek Bay
Willow Point
Portage River
Portage Creek
Shore Line Rte
ERIE Co
SANDUSKY CO.
RILEY
TOWNSEND
Peninsula Bay
Bridge
Johnson's Island
BAY
Venice
Sandusky
MARGARETTA
Cedar Point
Ridges
Dunes
LAKE ERIE
Pipe Creek
Marsh
Bar
590'
580'
Rye Beach
PERKINS
HURON

MAP II.

RECESSION OF THE BAY SHORE.

Map II shows the present shore line taken from the topographic sheets of the U. S. Geological Survey except the northeast portion, the sheet for which has not yet been issued. The broken line shows a portion of the shore as it was at the time of the first surveys 1809–1820. In quite a number of places lines running from section lines to the bay shore whose length is recorded in the original surveys have been remeasured in recent years by local surveyors or by myself and these data, as well as a comparison of the old plats with the recent maps published by the U. S. Geological Survey, have enabled me to estimate the amount of land lost. The greatest change has been along the south shore from Martin's Point west. Here the bay is wider than farther east and as erosion is accomplished mostly by the northeast storms, which raise the level of the water, the waves beat upon this shore with greater force than on the shore opposite. The west line of section 34 Portage Annexation, northwest extremity of Erie county I found in 1904 had shortened about 66 rods since the first survey. The middle line of the west half of section 35 Charles Judson found in 1895 had shortened 62 rods. At other places the change shown by surveys is not so great. However, the survey by Sylvanus Bourne, 1820, of Township VI North, Range XVI East 1st Meridian, at the west end of the bay, gives no measurements for the portion lying south of Mud Creek Bay and the shore line in this part of the township is not correctly drawn on his plat. Porter Wright who has owned much of the land in this region told me in 1904 that the whole west shore of the bay south from Eagle Island had washed away as much as eighty rods within his remembrance. He is seventy years old. At Dudrow's in Townsend Township he knows the recession of the shore is more than that. Miles Pearson thinks 100 rods of land north of the mouth of Raccoon Creek has washed away in the last fifty years and 60 rods between Raccoon Creek and Pickerel Creek in the same time. These estimates, H. A. Winters who also has long been familiar with the region, considers not too high.

At five places on the south shore of the western half of the bay, according to estimates of the several land owners, encroachment of the water has been from three to six rods in as many years, most of it in the last three years, because the water has been high. For seven or eight years preceding the last three there was hardly any encroachment in some of the places. In the western extremity of Erie county, where the road turns south, I found the bay eating it away, Sept. 2, 1904. The old

plat shows the nearest part of the shore 49 rods away. Charles W. White estimates that the shore was 15 or 20 rods farther north about twenty-five years ago. Just west of this the northwest quarter of section four, Townsend, contained:

1820		122.21	Acres.
1886	about	80	"
1890	"	70	"
1904	"	65	"

About an acre of this farm, i. e., a strip a rod wide, disappeared in the storm of June 29, 1902, already referred to and another acre in a northeaster the latter part of March, 1903.

The whole north shore of the bay from the mouth of the river nearly or quite to the bay bridge has receded since 1820, but less than twenty rods in most places. The west line of Section 4 Danbury township is given in the original survey, Wright and Mulhall's, as fifty-seven chains. In 1904 I found it to be but 47.11 chains, showing a loss of nearly forty rods. The shore line in their time was probably near where Presque Isle is now. South of section 9, Portage Township, were 21.42 acres of school land according to the survey of P. F. Kellogg, 1820. Only three acres of this now remain, but some forty rods south of the present shore may still be seen at time of low water the remains of a chimney marking the site of a house. J. W. Lockwood remembers being there about 1835 when there was quite a yard between the house and bay.

Between Venice and the western part of Sandusky the shore has receded about twenty rods.

The amount of land replaced by open water since 1820 may be roughly estimated as 2[illegible] square miles, without counting any west of Eagle Island. The amount converted into marsh, including the marshes west of Eagle Island, is probably eight or ten square miles so that the total loss of land about Sandusky Bay may be as much as twelve square miles.

MARSHES.

The recession of the shore line has been due both to erosion and higher water, the formation of marshes to the latter cause alone. The greatest change has occurred at the head of the bay. Seen from the deck of the Steamer Hayes, August 30, 1904, when about half a mile west of Winous Point, the marsh and open water appeared to extend three miles or more from north to south. A great part of this was dry land during the early part of the 19th century, but how large a part it seems impossible to ascertain. A plat of the region giving the results of a survey completed in 1893 by Edgar Brennan, C. E., distinguishes tilla-

ble land, including woods, from marsh. By inspecting this map and making a rough estimate of the percentage of tillable land in each section, I conclude that in the sections, Nos. 21, 22, 23, 26, 27, 28, 34 and 35, the total amount is not more than half a section. From the plat of Bourne's survey of 1820 it would appear that these eight sections then contained about 5½ sections of land. Part of this is now open water, part of it marsh. In several other sections of Bay township a good deal of marsh has formed within the past century. Porter Wright who went there in 1836 remembers that section 35, now nearly all marsh, used to be dry land. In section 2 of Riley township he owns 200 acres of marsh which formerly was dry land. Mulberry stumps are still standing there where now the water stands half the time. He estimates that more than a thousand acres of marsh south of Graveyard Island used to be dry land except after heavy rain. "Honey locust, elm and poplar used to grow over a good deal of the land where the water now (1904) is 2½ feet deep. All the way from the bay to Peach Island was good dry land, mostly prairie; there was a streak of timber half or three quarters of a mile south of the river, some of it still standing on the highest ground. All the marsh from Raccoon Creek to South Creek was prairie land covered with blue joint and hoop pole grass (Spartina cynosuroides), a grass seven or eight feet tall which does not grow where it is wet. The region between South Creek and Green Creek is now marsh, but when I came here it was mostly dry land."

The total amount of land west of Eagle Island converted into marsh or open water since 1820 is probably six or eight square miles. In Margaretta Township, Erie County, the recent topographic map shows about 1⅔ square miles of marsh. Most of this was probably above lake level until after 1820. On the north side of the bay the marshes are less extensive.

At the east end of the bay the marsh that extends from the mouth of Pipe Creek to Rye Beach has spread over considerable of the low land along its inner margin within the past century. Two miles east of Perkins Township the late Albert Judson, county surveyor, found the line originally run by Almon Ruggles and supposed to mark the border of the land at the time of the early survey, to cross the marsh about half a mile out from the present margin of the land, the water and mud over the intervening region being a foot to 18 inches deep. This was in 1887. A lot, half a mile square, had been converted into marsh. Between this and the Perkins Township line the recession of the shore line he found to be very much less. Walter Devlin says, cattle used to go out half a mile toward Cedar Point farther than

now and find pasture and places to lie down, though they had to wade through perhaps a foot of water near the hard ground from which they started, where the water was deeper than farther out.

WHAT THE WATER HAS COVERED.

SUBMERGED HUMAN REMAINS.

Squaw Island at the present mouth of Sandusky River rises two feet or a little more above mean lake level. The soil is sandy and probably alluvial. Graves have been found in all parts of the island including parts washed away in recent years. In some of these the bones were below the present water level. On August 27, 1904, I visited this island with John Fitzgerald, keeper of the Winous Point Club House, who had often found bones there. A cottonwood fifteen inches in diameter whose roots had been loosened by the high water had fallen on the land the year before, and had earth still clinging to its upturned roots. Imbedded in this earth I found a molar, a rib and two cervical vertebra, all human, also fragments of Indian pottery. All of these must have been beneath the water, probably a foot or more below the level of August, 1904. A few yards from this cottonwood another had fallen from the same cause and lay parallel to the first, its diameter about thirty inches. In the earth brought up by its roots Mr. Fitzgerald had seen human leg bones, which before the tree was uprooted must have been below the water a foot or so. That these graves on Squaw Island are not very ancient may be inferred from the fact that in one of them was found a silver gorget on which is engraved the lily of France. This is now owned by Charles Sadler of Sandusky.

The early French settlers about the head of the bay used to bury their dead on Eagle Island, which at the time was probably part of the mainland. Some thirty years ago the graves had been washed out and skulls still sound and other bones in great numbers lay on the beach.

Graveyard Island where the "French" or "British in 1812" buried their dead has been almost if not completely submerged at times of very high water.

On the north shore of the bay east of Hartshorn's dock, on land owned by Mary Cook, a grave was found in 1903 close to shore. There was a tradition among the old residents of the peninsula that at this point an Indian burying ground had once extended out where the bay is now.

At the northeast corner of the city of Sandusky, near the ship yard, copper kettles and Indian trinkets were washed out by the high water of 1858.

Graves of some of the early white residents of Sandusky just west of Ilg's brewery were opened by the waves so that coffins stuck out of the bank and bones fell out 1850-'52.

SUBMERGED FORESTS.

Persons who came to Erie county in the forties remember seeing about the marshes connected with the bay many dead trees which they believed had been killed by high water, as the trees were standing where it was too wet for such trees to grow. Allen Remington, who came in 1839, saw great numbers of dead trees that had been recently killed by high water standing where there is now marsh in the eastern part of Sandusky Bay. Lake Erie in 1838 reached a higher level than ever before. Many trees were killed also by the high water of 1858–62. George Hinde, who owned a large tract of land in the northeast corner of Perkins Township, Erie County, had hickory trees two feet in diameter killed at that time. In the northwest corner of Huron Township eighty acres or more from a tract of 213 owned by Walter Devlin had become marsh by 1904. On a good deal of this were walnut trees.

J. W. McGookey, who lives in Margaretta Township, Portage Annexation, says: "About 1858–'62 large trees of oak, elm, and many other kinds were killed by water standing over their roots, along all the farms near his place and on the school lands in the northwestern part of the township. Many other forest trees were washed into the bay, as was also an orchard north of the land now owned by Lewis Neill."

Jonas Pearson of Vickery, informs me that in or near the northeast corner of Riley Township, Sandusky County, sixty acres of timber, hickory, oak and ash, were killed a number of years ago when the water came up and stayed up several years. Porter Wright told me that in section 36, Riley Township, on land he formerly owned, oak, hickory and large elms were killed by high water at about the time of the Civil War. Also on land he still owns in sections 35 and 36, well back from the bay shore, all the biggest and best ash, oak, elm, and hickory, many of them he thinks two hundred years old, were killed at the same time. He never saw elsewhere such a heavy growth of timber as on Graveyard Island and Eagle Island. It was principally honey locust. In 1860 Allan Winters rowed his boat among the standing trees at the head of the bay. He says a hundred acres or more of them were killed by high water at that time. His observations were chiefly north of the river and so refer to different sections from those mentioned by Wright or Pearson.

In the part of the bay north of Townsend Township abundant remains of a prostrate forest extend out half a mile from the

present shore, according to J. W. Lockwood, who found them so close together as to make it difficult to steer a scow among them. Later J. G. Yeckley, who lives near, confirmed the statement that trunks with roots attached extend out half a mile from the present shore. He took from the water some five hundred trees still quite sound, using them for posts. They were mostly oak and hickory, though others got out a few of walnut. The main object in removing the timber was to clear the bottom so as to permit the hauling of seines. He spent parts of three years in this work.

In the marshes east of Sandusky I found in March, 1898, a number of prostrate trunks with roots extending down some distance so that I thought they must have grown there before the land had been converted into a marsh. A number of these were sixty rods or more from the present shore of the marsh. From the shallower part of the marsh nearer shore I was informed that in a dry season hundreds of walnut trunks had been removed for timber, and that a number of walnut stumps were still standing where the ground was too wet for trees of that kind.

"In tracing the west line of *Huron Township across the marsh in 1885 it was found that the original survey made about 1810, referred to trees standing at different places where for many years past has been only marsh."—Ed. Hinde.

Hunters in pushing their skiffs through the marsh often strike submerged timber with their setting poles. Besides walnut I found basswood, cedar, pine, beech, and sassafras, but it is not certain that all of these grew near where they now lie. Planks have been found two or three feet below the surface of the marsh. The floods of 1858–'61 carried not only these but many trees that had been uprooted. All that had been growing on Cedar Point between the Carrying Ground and the vicintiy of Rye Beach were swept off into the marsh. These have perhaps all rotted since, but others of kinds more enduring that grew along the Huron River or other streams may have been carried into the lake by the freshets of that time and washed over the Cedar Point bar by the northeast storms.

Cedar stumps still standing where the trees grew have been found in several places about the bay, their roots and in some instances their tops below the water level. Sept. 11, 1904, the high water of the summer having washed away a portion of Rosebush Point (near the end of Cedar Point) I noticed a number of stumps, cedars and others, with roots at or below water level. A root of one of the cedars was fourteen feet long. Nov. 19 when I was on another part of Cedar Point the dredge at work near the south end of the lagoon between ridges No. 2 and 3

[*-note (2021): technically, "Huron Township" was not established until after the first surveys, (after which, the entire Cedar Point peninsula was included within "Huron Township" – its township "west line" went north through the marsh, but circumvented western Cedar Point.)]

brought up a cedar stump whose roots the men said must have been two or three feet below water level. The water at the gage at the time was about .6° below 0. They had previously found in the work on the lagoon three or four cedar stumps below water level, the roots two or three feet below.

In 1894 or 1895, Chas. Dildyne saw several cedar stumps in a group west of the Black Channel and not far from its mouth. They had been cut with an axe but their tops are below water except in very dry times. Three other persons have told me of seeing these same stumps or some in the same vicinity.

In 1894 and 1895 William Hertlein worked a piece of land between Venice and Bay Bridge, which other years has been covered with water. He found many cedar stumps still in place, The muck was three or four feet deep but the cedar roots were, partly at least, in the clay underlying it. The water in May, 1904, he said was as much as three feet above the uppermost roots.

SUBMERGED MARL BEDS.

The marl used by the Sandusky Portland Cement Works at Bay Bridge was formed from calcareous springwater probably above lake level. The greater part of the two hundred thousand tons used for cement has been taken from below mean lake level, the bottom of the deposit being about five feet below.

At Willow Point a gravel beach half a mile long several rods wide and rising two or three feet above mean lake level has been formed of pebbles most of which are calcareous tufa. The marsh back of the beach rests upon clay and contains no tufa. The pebbles must have been derived from tufa beds that formerly existed where the bay now is, but at what level cannot be told.

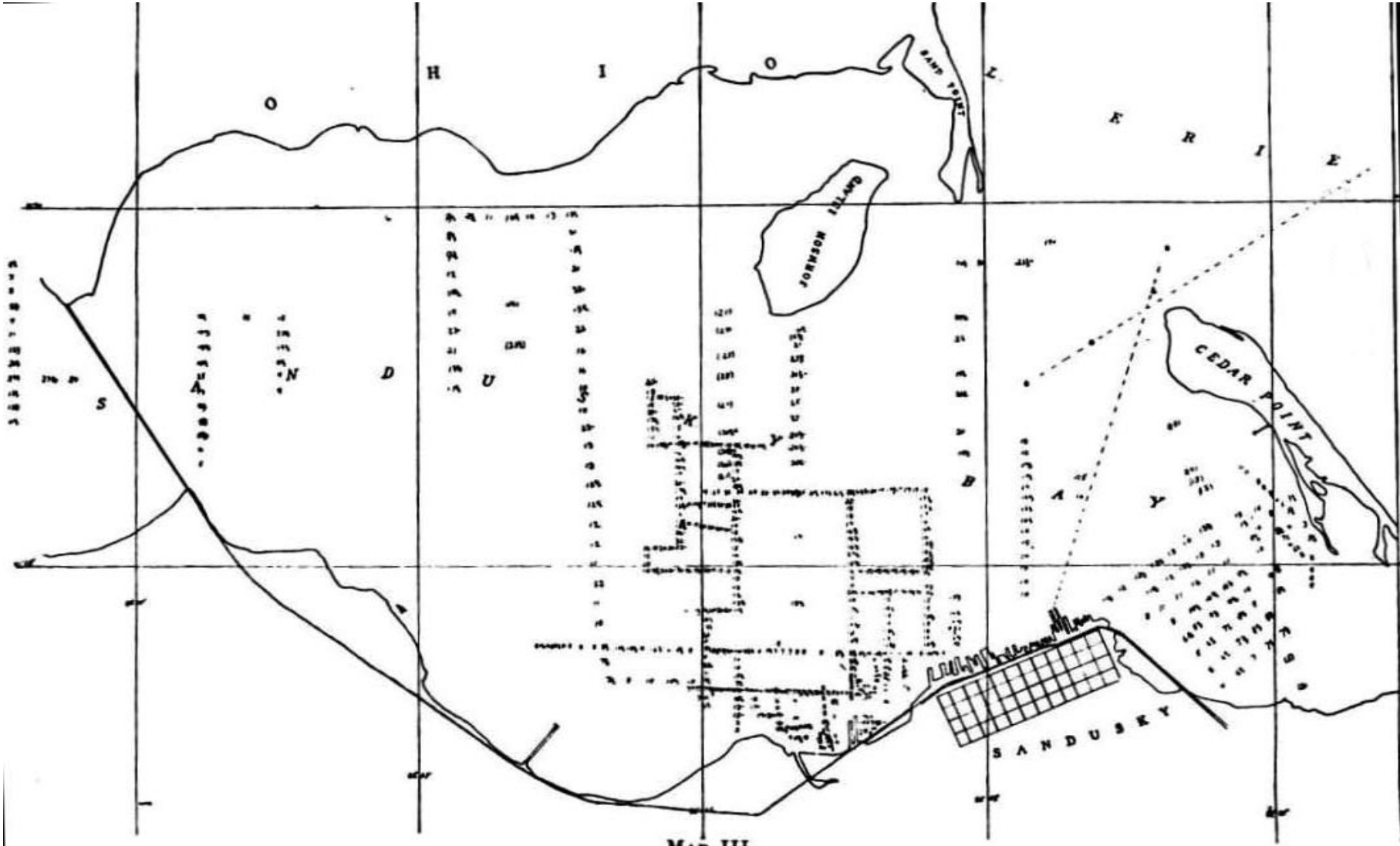
SUBMERGED VALLEYS AND THE BOTTOM OF THE BAY.

The possibility of tracing the valleys of streams through the bay occurred to me in 1898 while gathering data in regard to submerged timber in the marsh east of Sandusky. A hunter who had often pushed a boat through the marsh told me that along a line extending out from the mouth of Plum Brook a setting-pole would go down through the mud about 12 feet whereas on either side it struck hard bottom at two or three feet. A fisherman of whom I enquired regarding the character of the bottom of the bay told me that in setting stakes for his nets west of Johnson's Island he had found that the soft mud was very deep along a line from the bay-bridge toward the range-lights south of the island.

In January, 1901, I began making holes through the ice and testing the bottom by means of an auger welded to an iron rod along which would slide an arm provided with a set-screw, making it convenient to push, turn or lift the auger at any depth the rod would reach. The water of the bay is mostly less than 12 feet deep. The rod used the first winter was 18 feet long. Where the mud was very deep extensions were put on. The original rod was lost with the point about 30 feet in the mud and 39¼ feet below the surface of the ice near the old range lights south of Johnson's Island. Later I used a rod 20 feet long with an extension piece 12 feet long.

The bottom of the bay is nearly level so that soundings giving the depth of the water do not disclose any valleys (Map IX). By testing the bottom at numerous points along lines transverse to the general course of the stream it was found that off the mouth of each stream was soft mud containing organic matter and readily distinguished from the glacial drift on either side. It had been thought the glacial clay might be softened by being covered by water so long, but experience showed that as a rule the weight of two men would push the auger but a few inches or a foot or two into this clay, whereas it might be pushed twenty feet or more into the deposits made since the glacier. The agitation of the water by waves has caused the loose mud to fill the original valleys, making the bottom of the bay approximately level. These valleys made by the streams, when they flowed miles farther than now to reach lake level are thus traceable by the lines of soft mud.

On the maps showing the location of borings it is not a fault of the draftsman that the lines are not parallel and do not intersect others exactly at right angles. On these maps I have attempted to give the location of the borings as actually made, though it may have been the intention to make them along north and south or east and west lines. The difficulties in always carrying out such intentions were several; unreliability of a compass in determining the directions accurately; mist obscuring landmarks I had intended to use; errors in maps and charts. In some of the earlier work the drawbridge across the bay in the L. S. & M. S. bridge was used as a landmark. After a time it was discovered that more than ten years before the drawbridge had been changed to a position nearly 1000 feet farther southeast but that the charts of Sandusky Bay with corrections to date still represented it in the old position. The platting of work done east of the mouth of Pipe Creek and in the marshes beyond was especially difficult because the border of the marsh is so indefinite and there was nothing in the vicinity



MAP III.

Figures show distance in feet from upper surface of

from which measurements could be made, and scarcely anything visible within two miles whose location is given on any chart or map. The plat in the auditor's office was found to be in error to the extent of forty-five rods. No detailed and accurate map of the region exists to this day. In the work done the first winter the importance of careful location of the holes with reference to points on shore was not realized, their location with reference to other holes sufficing to show—what was not previously known—that it was possible to trace these submerged valleys. Sometimes in tracing a valley it became desirable to test the bottom a short distance to one side of the line we had been following. Accordingly we measured off 16 rods or some other distance at what seemed to be a right angle to the main line and on making a hole there decided to go farther in the same direction. The deviation from the direction intended was usually discovered in some way either before or at the time of platting the work on the charts, even though it required a journey of several miles the next day to reach the spot again and trace the angles on paper. The location of borings shown on Map III, with the exception of those enclosed in parenthesis, are believed to be correct within ten rods or a little more, most of them much nearer than this. With reference to other borings in the vicinity the error in the location is very small, if made the same winter.

Nearly a hundred boys have assisted in this work and in determining the age and height of the aqueous deposits in the ridges on Cedar Point, some of them many times. Altho serving without pay, often in bad weather and enduring fatigue they have made no complaint. I wish there were space to mention their names. On one occasion a boat was taken along on the ice, at another time a life preserver. Both proved useful. Twice at least the shore has not been reached until after dark and on one of these occasions there were some anxious parents. Many mittens have been lost or discarded and many tools, large or small, gone to the bottom of the bay or farther, but no lives have been lost or limbs broken. Feet have been wet and sometimes more, but few colds have been taken and many probably avoided or cured by the vigorous outdoor exercise.

I am indebted to Mr. August Klotz who has generously put at my disposal without charge the resources of his machine shop, and to Charles Judson, C. E., who has often loaned me his instruments and assisted in other ways.

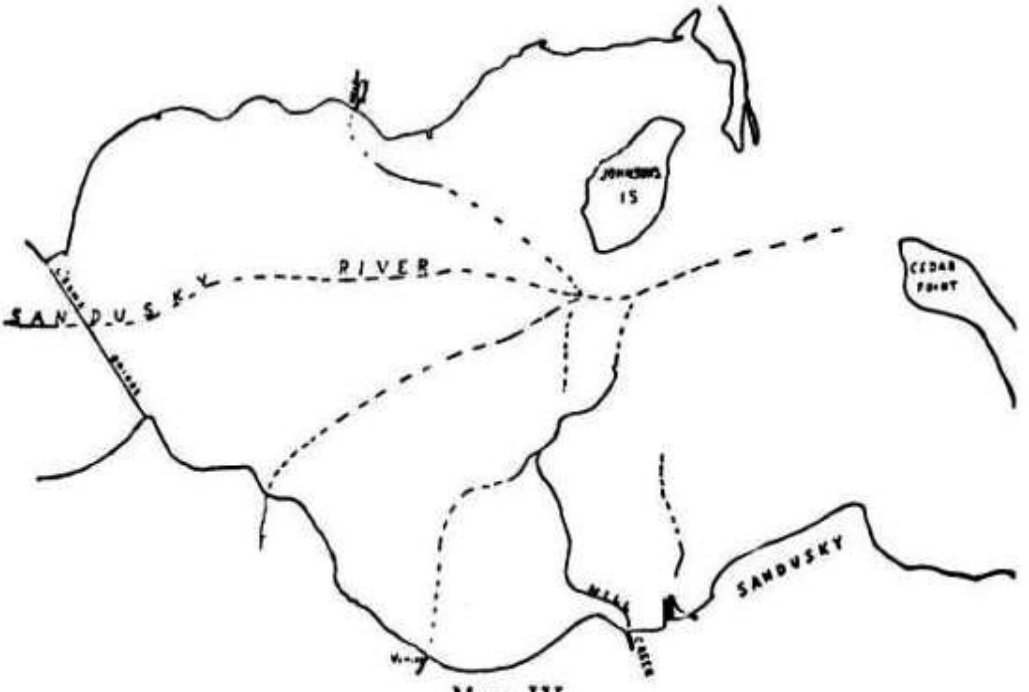
SANDUSKY RIVER.

I have not tested the bottom of the bay farther west than Danbury, 82 degrees, 50 minutes west longitude, but Adam Hayder in driving stakes for fish-nets has noticed a zone of deep mud extending from Eagle Island to the Bay Bridge. Into this he drives the stakes six feet and then does not know that they touch clay. This belt of deep mud is as wide as the length of eight leaders, 35 rods each, and the northern margin of it is about this distance, seven-eighths of a mile, from the shore at the Plaster Beds and as much as a mile at the Port Clinton road. From the south side of this belt of mud on the meridian of Port Clinton hardpan extends toward Willow Point. Off Willow Point for the length of six leaders, stakes will hold, but the next six lengths stakes do not hold, the blue clay or hardpan being too hard.

I found no place near the bay bridge where the hard bottom was quite thirty feet below the ice. It is not likely that anywhere farther west the river ever cut much deeper than this, for in the portions of the bay bridge where piles were driven the rock is nowhere much more than thirty feet below mean lake level. Nor does the valley deepen appreciably for about three miles east of the drawbridge. South and southwest of Johnson's Island a depth exceeding thirty feet was found in quite a number of places. Here the river received several tributaries and its valley is probably considerably deeper than farther west. The borings do not show any tributaries farther west and it is not likely that any important ones existed between the bay bridge and the vicinity of Johnson's Island. Among the old dismantled range lights southeast of Johnson's Island the hard bottom is at least forty feet below mean lake level and may be considerably more than this. The greater part of a day was spent in attempting to trace the valley farther east but deep sand prevented reaching the clay except in a few places. The deep water off the end of Cedar Paint and in 1842 a deep depression between the end of Cedar Point and the dismantled range lights, with glacial clay only 20 feet below lake level a short distance to the south and to the north, show that the Sandusky River once flowed where steamers now pass in and out of the bay.

TRIBUTARIES TO THE SANDUSKY RIVER.

Lines of borings across the bay indicate the course, though they do not show in detail, the submerged valley of Meadow Brook which now enters the bay west of Hartshorn's dock on the Peninsula, and a stream now entering the bay east of Bay



MAP IV.
Buried Valleys under Sandusky Bay. Compare with Map III.

Bridge station giving outlet to the water from the Rockwell springs and formerly the other bold springs at Castalia. By means of a canal the water of these other springs has been diverted to the stream that discharges at Venice. This stream five hundred years ago extended nearly two miles farther northeast than now, joining Mill Creek about 82 degrees, 45 minutes W. longitude, 41 degrees, 28 minutes N. latitude. The former course of Mill Creek has been worked out in detail but near its confluence with Sandusky River south of Johnson's Island its location is not entirely certain. Here the river valley was probably so deep below the surrounding country that even short tributaries cut deep ravines on approaching it and the multiplicity of these makes it difficult to work out the ancient topography in detail.

Between Mill Creek and Pipe Creek no important streams enter the bay nor do the numerous borings indicate that they were ever here. North of Sandusky the surface of the clay slopes gradually toward the former course of the river.

East of the Pennsylvania Railroad dock a little creek formerly entered the bay. Its water is now carried by Whiskey Run sewer. The valley was easily traced as far as the dock but, owing to its small size and the fact that its banks were cut down by the waves of the bay, I was long puzzled to know what became of it beyond the dock or dredged channel. Certain

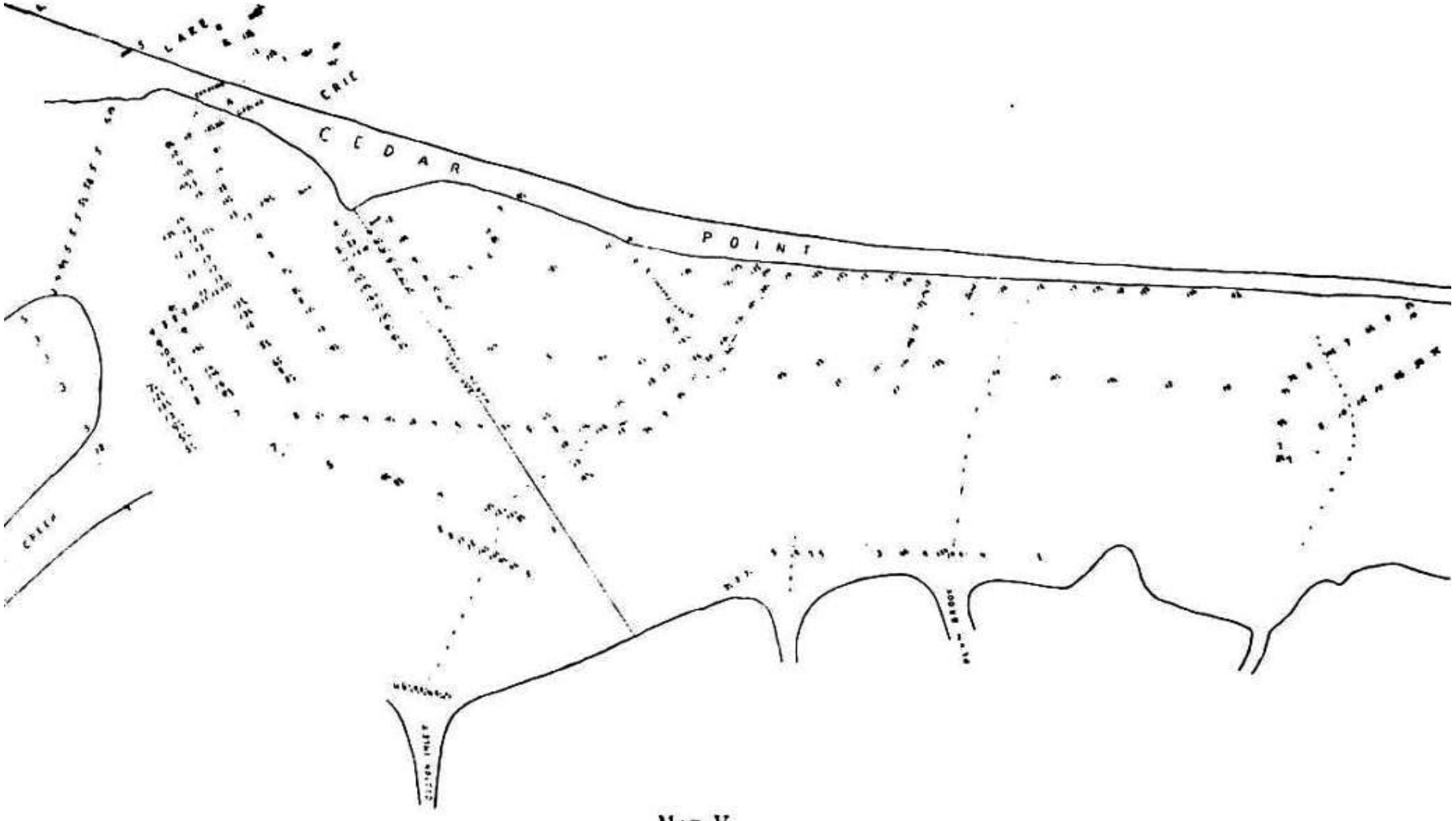
spots farther north where the mud is deep, found when making lines of borings not designed to show the valley of this stream, were supposed to be due to it, but the connection was not found until a number of trials were made. From the Pennsylvania dock the valley extends nearly north.

PIPE CREEK.

The tracing of the former course of Pipe Creek was not satisfactorily completed until parts of four winters were devoted to it. The first attempt, March 16, 1901, served to show that it was traceable, but the work could not be carried far because of the weakening of the ice which in the warm sun thawed rapidly that day—more rapidly than in the open bay where the water under it is deeper and consequently not warmed so fast. In the following winter many borings were made between Pipe Creek and Cedar Point and the valley appeared to reach the Point near the west line of Huron township. When, however, the borings were platted as well as the poor maps would permit it seemed probable that the deep muck near the west line of Huron Township was due to the former confluence there of two small streams not shown on the maps, though they may be seen by one walking along the L. S. & M. S. R. R. east of Pipe Creek. They must have broadened and deepened as they went on through what is now marsh. Deep muck found near the Carrying Ground was assumed to be in the submerged valley of Pipe Creek. The next winter we were disappointed in finding the ice unsafe east of Pipe Creek, but in December, 1903, we traced the valley without any difficulty from the present mouth of the creek to the Carrying Ground and later in the winter under the Carrying Ground and out into the lake.

VALLEYS UNDER THE MARSH.

Some long lines of borings in the marsh east of Pipe Creek together with some shorter ones near the mouths of the streams served to show quite well the buried valley of Guston Inlet and less fully that of Plum Brook and a small stream entering the marsh beyond the West Huron Club House. All these valleys are filled with muck that is easily penetrated by the auger. Mingled with the organic matter is alluvium brought by the streams in time of flood and in the vicinity of Cedar Point a small amount of sand, some of it no doubt having been blown over the ice in winter.



MAP V.

ıried valley of Pipe Cre k and of streams entering the marsh farther east. Figures show depth in feet of clay below upper surface of ice.

THE BLACK CHANNEL.

This does not properly belong under the head of submerged valleys but as it is popularly believed to be a remnant of some former stream, it seems best to mention it here. As the entrance to Sandusky Bay was much narrower in the early part of the 19th century than now, it has been supposed that at an earlier date no opening existed there but the course of the Sandusky River was continued by the Black Channel and the outlet was at the farther end. This is disproved by the fact that glacial clay and even rock make a continuous barrier between Sandusky and Cedar Point.

The Black Channel and the smaller channels running through the marsh do not follow the buried valleys. The latter pass under them and have no connection with them. These modern channels give outlet to the bay for the streams which a few centuries ago had separate outlets into the lake. They also serve to distribute the water over the marsh or carry it from the marsh when the wind raises or lowers the level of the bay. At such times the currents may be quite strong and this serves to keep them open and deep as they are. They may be compared to the tidal inlets in the salt water marshes.

The Black Channel has had its present position for at least sixty years. It is not, however, very old because three centuries ago Pipe Creek and the streams farther east had no connection with Sandusky Bay. Then there was not a continuous marsh extending from Pipe Creek to Rye Beach but each creek was bordered by marsh separated from those on each side by dry land.

CHARACTER OF THE POST-GLACIAL DEPOSITS AT THE BOTTOM OF THE BAY.

These have not been studied carefully, the aim having been to find the depth of the glacial deposits below the surface. In the West Huron marsh the material overlying the glacial clay is composed largely of the remains of marsh vegetation, black or dark brown, extending in places to a depth of twenty feet. In the submerged valley of Mill Creek muck was found at a depth of 32 feet of such purity as to show that a marsh once existed there. Sometimes on withdrawing the auger marsh gas bubbled up through the hole in the ice; on one occasion it issued in considerable volume so that when lighted it produced quite a blaze. In this and other valleys in the bay muck has been found at various depths, but it does not constitute a large percentage of the material filling the valley. This must have been transported

and in most instances probably consists of a mixture of materials from many places, some of it washed into the bay by streams, some derived from action of the waves on the shore. Materials from the same sources are found over much of the bottom of the bay but I do not recall finding muck or other remains of old marshes far from the present shores except in the submerged valleys.

The thickness of the post-glacial deposits in any part of the bay can be determined approximately by subtracting the depth of the water given on the government chart of Sandusky Bay from the depth of the clay shown on Map III, allowing one or two feet for difference in water level at the times depths were determined. The water in winter is lower than in summer and so I have generally found its depth less than that shown on the government chart.

In some places scarcely any mud covers the clay. In many places the uppermost part of the clay is so soft that the precise level at which it is struck cannot be told from its resistance to the auger pushed into it, but when pulled out it clings to the auger and an inspection of it as it is being removed with a stick rarely leaves any doubt as to whether it is clay or mud. The latter not only looks different, but has much less tenacity. In a great majority of cases the clay is blue, but in some places both near the south shore and the north shore it is red, not having been long enough in contact with organic matter to reduce the ferric to ferrous compounds.

In some places, e. g., along the line extending north from the foot of Wayne Street to the Outer Range Rear Light, the transition from mud to clay is abrupt. Here the mud is so soft that it is difficult to tell when the auger first touches it and the weight of one man is sufficient to push the auger nearly or quite to the clay. The hard and nearly level surface of the latter probably indicates that it was planed off by the waves a few centuries ago when the lake and bay had reached a high enough level. Shore currents probably carried the products of erosion away, leaving the bottom free from sediment. When the water had become so deep that the lower layers were no longer subject to agitation by the waves, light particles easily held in suspension and so carried far from their source were deposited here, gradually forming a bed of soft mud resting upon the firm glacial clay.

In going north along this same line, which is on the meridian of the court house, no sand was noticed until we were a mile from shore, where it was barely perceptible, gradually increasing toward the north. At a mile and a quarter it was necessary to

turn the auger through six or eight inches of sand. From here on the sand increases rapidly. A quarter of a mile south of the Rear Range Light we bored through six feet of it without reaching the bottom. The layer of sand found between a mile and a mile and a quarter north of the city is not at the surface of the mud but a few inches below it, while several feet of mud intervene between the sand and the clay. As long as the entrance to the bay remained narrow it is probable that great waves traversing the lake were checked enough there to prevent sand being carried so far toward Sandusky, but when the washing away of Spit Island widened the opening much of the obstruction was removed and the great storms of about 1860 distributed sand (some of it, no doubt, derived from Spit Island) farther in the bay than it had come before. In later years the narrowing of the entrance by the construction of a submerged jetty extending northwest from the Outer Range Front Light as well as the scarcity of great northeasters may have prevented further accessions of sand and given time for mud to be deposited on top of that which was left here in former years.

We have never found thick deposits of sand except where it had apparently come in from the lake. The bar west of Biemiller's cove has much sand and gravel which has been moved along shore from the north, but a short distance west of the bar the sand forms only a thin surface layer.

WORK OF THE GLACIER AND PREGLACIAL CHANGES.

The glacier rested heavily on the region about Sandusky and left its impress on the rock in many places, the grooves of Kelley's Island and Marblehead being larger than are known elsewhere. Near the north shore of the bay large grooves have been noticed north-east of Hartshorn's dock and at the Ohlemacher quarries. Along the south-east shore of Johnson's Island are numerous distinct grooves extending beneath the water. On the higher ground back from shore they are continually being uncovered in stripping the rock as the quarry is extended and a number of fine ones have been quarried away in the last three years. In the city of Sandusky wherever the overlying clay is sufficiently deep to protect the rock from weathering, its removal discloses glacial marks. Near the bay we have noticed them at the Ship Yard and in the basement of Emerich's drug store. In the summer of 1904 when the foundation was being prepared for the concrete work at the foot of Columbus Avenue, a piece of limestone showing plain glacial marks was broken off twelve feet below the surface of the water.

Besides the valley now partly filled by Sandusky Bay several other rock valleys in the vicinity lie sensibly parallel to the main axis of Lake Erie.

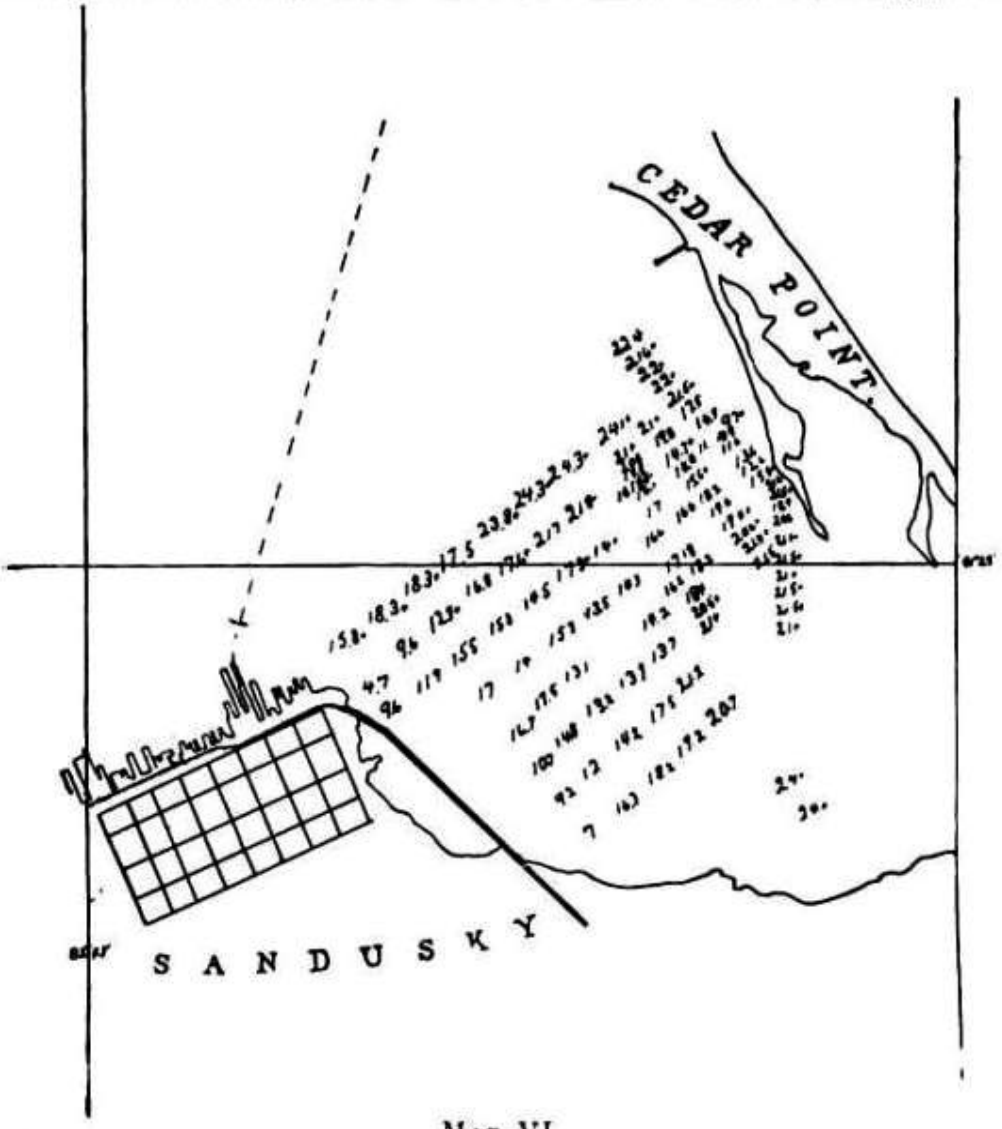
The parallelism of these valleys to each other and to the grooves makes it probable that all of them were made by the glacier. Although the general movement of the glacier over Ohio was more nearly southward the motion of the lower portion of the ice in this vicinity during the time that most of the erosion was done was about seventy-five degrees west of south, the direction being determined by the valley now filled by Lake Erie.

Under the bay the glacial deposits are of the same character as on the land. Overlying the rock is hardpan from a few inches to two feet or more in depth, containing pebbles and boulders in abundance, the greater part of them of limestone which the glacier transported but a short distance. The matrix in which the stones are imbedded contains a large percentage of calcium carbonate which probably accounts for its toughness compared with the clay above it, which the auger penetrates with much less difficulty. In the lower part of the clay are boulders but not so many as in the hardpan. Pebbles are very numerous within a foot or so of the rock. Limestone boulders appear to predominate near the rock to a greater extent than at a higher level—judging from some exposures on the land. Except within four feet of the rock the clay seems to be almost free from stones of any size. It must have been held in suspension by the water of the glacial lake and gradually settled to the bottom at a distance from the foot of the glacier.

PREGLACIAL CHANGES.

No deep preglacial valley runs through Sandusky Bay. At the power house on Cedar Point the rock is 46 feet below water level. Off the end of Cedar Point the water is 40 feet deep. West of the entrance to the bay in 1842 was a circular depression in which the water was 42 feet deep. In the vicinity of the old range lights south of Johnson's Island soft mud extends to a depth of forty feet or more below mean lake level. I know of no attempts to find the rock at greater depths at the entrance to the bay or west of it. In the bay bridge of the L. S. & M. S. Ry. the piles are driven to rock which is in most places less than 30 feet below the surface of the water. The longest space without piles is 1700 feet but the rock does not slope toward it in such a way as to indicate a rock valley there. How much of the broad but shallow valley occupied by Sandusky Bay resulted from preglacial erosion I have no means of judging.

Gypsum has been quarried near the north shore of the bay, 3 miles west of the Bay Bridge, for about three quarters of a century. At first it was ground by a windmill, but about 1835 by a steam mill. Thirty-ton schooners anchored a mile out in the bay and loaded for Detroit, Erie and other ports. This is said to have been the only locality on the Lakes where plaster was obtained at that time. The gypsum beds lie mostly below lake level. Long ago about four acres of the bay at Plaster Beds were diked off, the water pumped out and gypsum quarried. A few years ago one of the plaster companies operating at Fletcherville several miles west of Plaster Beds mined gypsum



MAP VI.

Rock between Sandusky and Cedar Point. Figures give depth in feet and tenths below 0 of water gage. - indicates rock was not reached, but, if following a number less than 21, was probably within one foot.

[["**CEDAR POINT**" section begins below]]

under the bay until the water broke through the roof of the mine. Gypsum has also been found near shore between Fletcherville and Plaster Beds, and in 1902 a good bed was found 1½ miles south of the bay on Mr. Meggit's farm in Margaretta Township. In view of its occurrence both north and south of the bay and near the bay near the north shore it seems probable that it once extended over considerable of the region now occupied by the portion of the bay west of the bay bridge. The relatively rapid solution and erosion of the gypsum compared with the more resisting limestone may have produced this broad valley. Much of the earlier plaster was derived from boulders, so it is likely that the glacier assisted in enlarging this valley. East of Sandusky the depth of limestone below the surface is shown on Map VI. An inspection of this chart will show that over most of the region the rock is not far from level. It rises near the Sandusky shore and near Biemiller's cove. It drops off rapidly to the north just as it does along the city front, also to the east of a line extending from the Jarecki Chemical Works to the Lake Laboratory.

In other parts of the bay I have never struck rock except in a few places near shore, e. g., near the mouth of Mill Creek and near the south end of Johnson's Island.

CEDAR POINT.

Cedar Point is the peninsula, 7¾ miles long, forming part of the eastern boundary of Sandusky Bay. It is not, as has been supposed, a mere sand spit, but has a foundation of clay resting upon the rock and extending, in the middle section, nearly up to low water level. It may be divided into three portions which we will call the bar, the middle or dune section, and the terminal or ridge section.

THE BAR.

This is a low narrow strip of sand extending from Rye Beach, 2¼ miles west of the Huron River, to the Carrying Ground, a distance of about 4¾ miles. The height of the crest above mean lake level averages about 6½ feet, in the highest places barely exceeding ten and in the lowest descending to a little less than five. From the crest toward the lake a bare beach slopes steeply for a foot or two then gradually to the water whose height of course determines its breadth. At low stages of the water, such as prevail in fall and winter, the breadth is about four rods, continuing for miles with little variation. It does not

at any place extend out into wide reaches of sand flats for the water off shore deepens more rapidly than that adjacent to the terminal portion of Cedar Point. Away from the lake the slope is quite gradual and the distance from crest to marsh is between eleven and sixteen rods throughout a great part of the length. In the vicinity of the west line of Huron Township and the mouth of the Black Channel the breadth is twenty-four rods or more. Quite near Rye Beach the breadth in the fall of 1904 was only 2–4 rods and most of the way for the first mile between three and six rods. In a number of places the lake has washed the sand over onto the marsh making little projections two or three rods long, so that the shore of the marsh has not an even outline like that of the lake. Some of these were made in 1904 and others apparently within a year or two before.

COMPOSITION OF THE BAR.

The visible material of the bar like that of the remainder of Cedar Point is largely sand, consisting of quartz, magnetite and garnet, but unlike the remainder it has throughout its whole length gravel at the surface. On the bare beach the gravel is abundant and many of the pebbles are as large as hens' eggs, the quantity and to some extent the size increasing as one goes toward Huron, the direction from which they have come. They consist largely of quartzite and other metamorphic rocks derived presumably from boulders in the clay between Rye Beach and Huron. Limestone is scarce and not from any beds in the vicinity. Shale fragments flat, angular and dark are scattered over the beach or strewn thickly upon the sand more or less apart from the hard pebbles. They too increase in abundance as one approaches Dr. Esch's place where a bed of Ohio shale outcrops, showing many spherical calcareous concretions three feet in diameter, some of them with tops cut off by the glacier and still bearing the scratches.

Near Rye Beach fragments of brick of various sizes, rounded like the other pebbles, attract attention by their red color. These are probably from a brick house belonging to Jabez Wright, grandfather of Mrs. Esch, and a well known surveyor three quarters of a century ago. The house stood north of the present shore and south of a road, on the north side of which was an orchard. The lake took the orchard, the road, the house, and finally the man, who after a dark night was found dead at the base of a high bank where the lake had encroached upon the new road.

A list of the things washed ashore or drifted along the Cedar Point beach would fill pages. Among the more common

are fragments of wrecks, and other driftwood, articles of various sorts thrown or lost from boats, coal, cinders, nuts, fish, bones of various vertebrates and shells of molluscs. We once found on a lonely part of the beach the skeleton of a swan which probably after being wounded perished on the lake and was entombed in the sand near the crest of the beach by the same storm that brought it ashore. Even the cartilages of the trachea with its curious convolution inside the sternum were still preserved. Various things through long attrition by sand and pebbles have come to resemble the latter so closely that their nature is a puzzle to the novice—wood, coal, peat, brick, drainage tile, pottery and glass made opaque and quite free from sharp points or edges. The source of the last when its nature is comprehended may not be so puzzling to account for as that of the peat which occurs at various places along the lake shore to the very end of Cedar Point. This is derived from the remains of marsh vegetation which once flourished where the lake is now. The bar is not so far out as formerly and part of the marsh that was originally behind it is now in front of it. These fragments are perhaps broken loose in winter, when the water is low and the ice that has been resting upon the exposed marsh, sometimes in winrows ten or fifteen feet high, is drifted ashore by the wind. At least I found many large and angular ones nearly free from sand after the ice had broken up Jan. 1, 1905. Some of them were fifteen inches thick and more than four feet in length. A long line of these extended northwest from a point about 2½ miles from Rye Beach. Toward Rye Beach for quite a distance none were noticed though within a mile or so of it there were a dozen or more, increasing in size toward the beach, the largest eighteen inches long. There are never large ones on this part of the beach. The small ones are derived from the marsh at the outlet of Sawmill Creek close to Rye Beach. The portion of this marsh now covered by the lake bristles with the roots of buttonbush so close together that no large masses of muck are loosened from among them. A third locality from which the muck is derived is probably along the shore of the Carrying Ground.

Between the buried valleys of Plum Brook and Sawmill Creek the clay is probably so near the surface that soon after the marsh muck was uncovered by the lake moving the bar over onto the marsh, it was torn loose and perhaps ground to pieces by the waves but I cannot say but what some still remains where it was formed and now covered by the sand and water of the lake.

Allen Remington and Jacob Lay have seen large quantities of peat cast ashore by storms occurring when there was no ice. The former says the storms accompanying the high water of

1859 uncovered the bog and threw large masses of peat on the shore in such numbers that one could follow the shore for miles jumping from one to another. In 1904 we found peat in the sand between two ridges near the lighthouse which were formed about 1860. It had been moved along the shore and cast up by the waves. Years later Mr. Lay saw peat strewn along the beach almost as thickly as described by Mr. Remington.

VEGETATION OF THE BAR.

The vegetation of the bar is scanty and limited with rare exceptions to such species as grow on poor soil. Andropogon scoparius, Panicum virgatum, Populus monilifera and Salix of several species—amygdaloides, wheeleri, cordata, lucida, alba vitellina—constitute probably nine-tenths of it all. On October 8th I walked the whole length but with that exception have not traversed the greater portion of it, save in winter. Besides the species mentioned above, the following are all that I have noticed, those among the first being more common than those toward end of the list.

Solidago canadensis
Teucrium canadense
Asclepias syriaca
Verbascum thapsus
Oenothera biennis
Euphorbia polygonifolia
Ptelea trifoliata
Cornus
Vitis riparia
Celastrus scandens
Rhus typhina
Nepeta cataria
Erigeron canadense
Andropogon furcatus
Sporobolus cryptandrus
Muhlenbergia mexicana
Cenchrus tribuloides
Lycopus sinuatus
Gentiana andrewsii
Pastinaca sativa
Equisetum robustum
Equisetum pratense
Prunus virginiana
Platanus occidentalis, 8,
Ulmus americana, 4,
Quercus velutina, 5, all small,
Quercus imbricaria, 1,
Fraxinus pubescens, 2,
The last three species near Rye Beach only.
Rosa carolina
Achillea millefolium
Xanthium canadense
Gnaphaluim polycephalum
Eupatorium perfoliatum
Strophostyles angulosa?
Lathyrus maritimus, about a mile and a quarter from Rye Beach, the only place I have found it in Ohio.
Liriodendron tulipifera, one,
Neillia opulifolia, one.

Doubtless a dozen more could be found by searching in summer for a single day, perhaps a score by trespassing on the marsh a yard or two, but compared with the 395 species, or thereabouts, which I have found on the older portion of Cedar Point, this list is small indeed. In all this barren waste of nearly five miles there is not a cedar nor pine and I believe no maple, black cherry, hackberry, mulberry, basswood, locust or any nut bearing tree, except a few oaks within three quarters of a mile

of Rye Beach and too young to bear. Aside from cottonwoods, willows and one of the buttonwoods I noticed but a single tree more than about twenty-five feet tall. Of plants as common in the dune section of Cedar Point as the cactus, bearberry and sea sand-reed I saw not one on the bar.

Between the crest and the vicinity of the marsh only a few of the plants in the preceding list are met except at rare intervals, a waste of beard-grass and panic-grass with here and there a cottonwood or willow being all that meets the eye. Throughout the entire length of the bar and also in much of the dune section the vegetation is scanty except in a narrow belt along the bay shore. Here the wind that blows across the sand transporting the finer grains has its velocity checked by the marsh vegetation and so drops its load. Moreover the bar slopes so gradually from the crest that a strip several yards wide near the bay is but a few inches above water level.

As water may be found anywhere by digging down to lake level, the sand near this level is kept continually moist by capillary action, but several feet above it the sand at the surface often becomes quite dry. Even at the same height above the water the fine sand contains much more water than the coarse and so is better suited to meet the needs of plants. To test the two sorts, sand was taken from among the bushes near the bay and from a point a few rods nearer the lake where the vegetation was scanty. The former was much the finer. The following experiments were tried with them. Hollow cylinders of glass and iron with cloth tied over the bottom were filled with sand and made to stand upright in shallow water so that the water was drawn up through the sand by capillary action. The fine sand contained a small amount of organic matter and when thoroughly dry was not readily wet even by water poured upon it but once wet it drew up much more moisture than the coarse sand and retained it longer as shown by the tables.

cont.

CENTIGRAMS OF MOISTURE FOUND IN TEN GRAMS OF SAND TAKEN FROM TOP OF SAND FILLING PIPES STANDING IN SHALLOW WATER.

Date	Conditions	Height above bottom, cm.	Coarse sand	Fine sand	Difference
Nov. 9	Water in jar barely exhausted	14	45	115	70
" 10	Water supply exhausted more than 24 hours.....	14			40
Dec. 14	Water supply exhausted about five days.....	14	3	41	38
" 19	Water 3 cm. deep in jar.....	14	40	110	70
" 19	Water 1 cm. deep in jar.....	23	3	5	2
" 21	Taken from about 2 cm. below surface.....	20		38	
" 21	Taken from about 4 cm. below surface.....	17	33		
Jan. 16	Taken from middle of cylinder which had contained 14 cm. of sand. Water exhausted several weeks.....	7	4	56	52

RESULTS FROM PLANTING OATS IN COARSE SAND AND FINE SAND.

Date of planting	Number		Height above water cm.		Date Examined	Number sprouted		Height of tallest mm.		Height of shortest mm.	
	Coarse	Fine	Coarse	Fine		Coarse	Fine	Coarse	Fine	Coarse	Fine
Nov. 10	10	10	12	12	Nov. 15.	0	2				
					Nov. 16. 8 A. M.	1	7				
					Nov. 16. 11 A. M.	2	9				
					Nov. 17.	3	9				
					Nov. 18.	3	9	47	71	3	37
					Nov. 22.	4	9				
					Nov. 28.	4	9	90	122	5	70
Oct. 26.	6	6	20	21	Nov. 7.	0	1				
					Nov. 9.	0	1				
					Nov. 12.	0	2		21		13
Oct. 26.	6	6	70	70	Nov. 9.	0	0				
					Dec. 12.	*	†				
Oct. 27.	4	4	8	8	Nov. 9.	1	0				
					Nov. 17.	1	0	120			
Nov. 17.	4	4	8	8	Nov. 22.	3	2				
					Nov. 28.	4	2	67	65	25	63
					Dec. 12.	4	3	95	80		55
Oct. 27.	2	2	8	10	Nov. 22.	0	2		60		32
					Dec. 12.	0	2		100		97

* No roots. † One with roots 40 mm. long, another 23 mm.

[[note for page "217": *"Huron Township"* was not technically established until after the 1807 survey. Afterward, the entire Cedar Point peninsula was included within "Huron Township":]]

THE BAR ENCROACHING ON THE MARSH.

In 1885 Albert Judson, county surveyor, found that the west line of Huron Township had shortened "twelve rods" since the original survey made by Almon Ruggles in 1807. Near Rye Beach he found the shore had moved landward about "twenty rods." A survey made by Rolla Chase in 1903 at the eastern border of Rye Beach showed the lake had there encroached on the land about 25 rods since 1816. The marsh at the outlet of Sawmill Creek, just west of Rye Beach, formerly extended out where the lake is now. The present marsh is well filled with living buttonbushes. In the lake on the other side of the bar the roots still stand where buttonbushes formerly grew. They have been seen as far out from the present shore as "fifteen rods." Some may also be seen projecting through the sand of the bare beach and one of these was noticed with green leaves. The cut bank and a few undermined trees show recent encroachment of the lake on the part of the bar extending from Rye Beach a little more than a mile. Some of the sand and gravel washed out has been carried over onto the marsh as may be seen in a number of places; more of it has probably been transported along the beach toward the northwest.

At the mouth of the Black Channel I found that on the bar near the bay shore the auger after being turned through three or four feet of sand could be pushed to a depth of ten feet below water showing that here the bar had encroached on the marsh. This was Dec. 27, 1901. Attempts made the following month at four other places on the bar were unsuccessful in finding muck. In one of them the auger after boring 8 feet through the sand was stopped by a pebble or other obstruction. In the others it was turned after much labor to a depth of 11, 13, and 18 feet, and pulled out with improvised levers and in the case of the deepest a little turning. This led me to doubt whether the whole bar had moved onto the marsh. However, Jan. 28, 1905, I found a place in the marsh several rods from the bar where so much sand was mingled with the muck as to make it impossible to push the auger through it. The same day we succeeded in pushing the auger through several feet of muck beneath the bar a little less than two miles from Rye Beach. This convinced me that at the places where I had failed to find muck, the reason was that it had become so filled with sand as to prevent pushing the auger through it. In one at least of the places where trial was made Jan., 1902, the sand brought up was blackened with organic matter.

At the Carrying Ground the bar rests on marsh muck and the muck extends out under the lake at least 38 rods, probably

[[note (2021): The earliest surveys headed by Ruggles, here, did not include the entire shoreline of Cedar Point peninsula (island). Prior surveyor's crude estimations were instead utilized.]]

much farther. At one place the muck under the bar was found to extend to a depth of 18 feet below water level. In the lake 30 rods from shore the muck extends to a depth of 10 to 13 feet along a line parallel to shore more than 60 rods in length. In the deepest place it doubtless is quite as deep as under the bar, 18 feet, though where borings were made, the clay was not more than 13 feet from the surface.

Much of this submerged bog had but a few inches to a foot or two of sand over it when I examined it in February and March, 1904.

At two or three places in the lake between the Carrying Ground and Rye Beach unsuccessful attempts have been made to push the auger after turning it some distance into the sand. A little more than two miles from Rye Beach the auger was turned down to 9 feet below top of ice and turned more easily the last two feet than nearer the surafce, as if the muck still remained, but with sand enough in it, to prevent pushing the auger through it. In driving stakes for fish nets more than a hundred rods off shore a mile and a half or so southeast of the mouth of the black channel Captain Steible tells me they used to strike what they believed to be muck. A large blunt stake would rebound and penetrate but little at each blow. This was where the water was sixteen feet or more in depth. He has seen along the beach when the water was low a sheet of muck two or three rods long. The sand usually prevents one from seeing any muck until it is washed ashore.

In the season of low water from 1891–1901 there was probably no encroachment on the marsh excepting that produced by the wind, and the trees along the shore of the marsh show that there has been no general encroachment for several decades. But the northeasters at time of the high water of 1858–1862, swept away the trees, and moved the whole bar over onto the marsh. Allen Remington remembers one cottonwood in particular, which served as a landmark for fishermen, much larger than any tree now on the bar. It stood not far from the mouth of the Black Channel and about 1856 was nearer the bay shore but when he began fishing, 1859, was about midway between the bay and the lake. In a few years more the beach had moved to it and it fell into the lake. At the point where this large cottonwood stood the encroachment on the marsh prior to 1857 could not have amounted to much during the life of this tree, else the shore of the marsh would have been farther from the tree but the fact that throughout much of the length of the bar there were no large trees probably indicates that it had not remained stationary for a great length of time.

Later than 1864 John Steible used to tie his boat to large stumps in the lake about where Remington's cottonwood stood. He remembers a three-foot cottonwood that stood a short distance southeast of the Carrying Ground and a few other large ones near it but no large trees of any sort on other parts of the bar.

OPENINGS THROUGH THE BAR.

At times of very high water openings have been made through the bar deep enough for the passage of fishing boats. According to Jacob Barker there was an opening in 1838 at what he called the lower carrying ground at or near the mouth of the Black Channel. The high water of 1858–'60 raised by northeast gales washed over the bar throughout its whole length. About 1858 Palmer Jackson witnessed the rapid enlargement of an opening at the Carrying Ground. When first seen it was about ten feet wide, but in half an hour had widened to twenty rods and later to more than a quarter of a mile. Many willows and other bushes were swept away. In the spring of 1859 the high water cut through the bar about 2½ miles from Rye Beach, i. e., a few rods west of the east line of section 4 of Huron Township. Allen Remington remembers this as being open all that season. James Galloway thinks it remained open four or five years. He says it was about thirty feet wide at the top and deep enough in the deepest part for a pound boat. The correctness of the location as given by him is confirmed by the fact that near the spot he assigns I found in the marsh several rods from the bar so much sand mingled with the muck as to prevent pushing an auger through it. Captain Steible recalls an opening at or near the same place about 1867–'69 though it was not open for about three years after he began going there, i. e., 1864. On the lake side it was choked with sand and re-opened a number of times. The Clarks who used to haul their fish along the beach to Huron were prevented for some time by this opening. He has seen the water go over the bar for its entire length. He built a breakwater to prevent his fishing shanty located on about the highest ground from being washed away. The water covered the floor of the shanty a number of times. He says the bar is higher now in many places than it was then.

About 1876 or 1878, also years of high water, an opening was made through the bar near the southeast end of the Carrying Ground. Through this Jacob, Henry and John Lay, who had nets in the lake, passed several times with a pound boat. It was formed by a severe northeast storm in the spring, the water going over the bar for a mile or more. It remained open at least

till some time in the summer but was closed again in the fall and reopened a year or two later. The sand point projecting into the bay at the west line of Huron Township is supposed to have been formed by sand washed through an opening. In the bay near this point the muck extends to a depth of twenty feet. A few centuries ago two small streams united a short distance to the southwest of this point as shown by borings in the marsh. The valley of the united streams passes under the bar at this point. (See Map V.) In the bay near by is sand overlying the muck and probably brought in through the opening. Jacob Lay remembers the opening of 1876 or '78 as being near this place, but others say it was farther northwest.

Since 1878 I think there has been no opening through the bar except at the mouth of Sawmill Creek near Rye Beach which in time of flood sometimes forms an outlet into the lake which soon becomes choked with sand like the mouths of all the small streams entering the lake and, it is said, even the mouth of the Huron River in the early part of the 19th century.

The Carrying Ground, as it is generally known in Sandusky, is at the northwest extremity of the bar. The Indians and later the white fishermen used this as a portage, for it is narrow and low and conveniently located for reaching from the lake either Sandusky or the mouth of Pipe Creek. Prior to 1875 whenever the wind was not fair for sailing around Cedar Point, the fish which were often caught in the lake in large quantities were carried across here and much labor and trouble saved thereby. At that time the pound boats were smaller than now and not so well adapted to beating around the point. Until about three centuries ago Pipe Creek had its outlet here.

DUNE SECTION OF CEDAR POINT.

This part of Cedar Point extends from the Carrying Ground to the head of Biemiller's Cove, a distance of two miles. Its topographic features are to be shown on a revised edition of the Sandusky sheet published by the U. S. Geological survey. Underlying it the clay, deposited when a glacial lake still covered the whole region, has its upper surface but little below the present water level. Here there has been land ever since the disappearance of that ancient lake, known as Lake Warren, caused by the retreat of the glacier. Until less than three centuries ago this land was connected with Sandusky by a strip of land lying north of Pipe Creek as shown by borings. (See Map V.) It is not, like the bar, a mere wave built formation. Its breadth

and its irregularities are due, in part at least, to the surface of the underlying clay which had been modified by subaerial erosion when Lake Erie was yet at a distance. This erosion, moreover, must have been held in check in so level a region by the proximity of the underlying rock which in parts of Biemiller's Cove is less than 12 feet below the mean lake level of recent years.

BIEMILLER'S COVE.

Biemiller's Cove does not represent a valley in the clay but the crest. At one point the clay was found immediately under the ice and extending down to rock less than nine feet lower. At another point it was less than three feet from the surface. About sixty rods from the north end the clay is covered with some ten feet of muck. Several centuries ago, before the lake had attained its present level sand and gravel were piled up along the northeast shore of this land and the bay formed smaller deposits on the southwest shore. In time the water became high enough to cover most of the land between these deposits, forming a marsh both margins of which have since been covered by the sand. Near the cove and northwest of the Lake Laboratory the roots of large trees and an old cedar stump still retain about the same relation to the surface as when the trees started two or three centuries ago. A scow run ashore south of the Lake Laboratory about 1881 shows no appreciable change in the shore since that time. But in driving pipes for the Laboratory well, 1903, Mr. Appell found that after the point was down 12 or 14 feet below the surface of the ground, it drove the next 18 inches or so very easily, and after that hard again. When the point was in the part where it went down so easily he pumped up water that was dark colored, containing fibers as if from a marsh or bog. How much farther east this marsh extended I do not know. On the other side of the cove just inside of the bar and nearer the head than the mouth of the cove I found beneath a few inches of marsh at the surface some three or four feet of gravel and beneath that about four feet of muck. This narrow part of the peninsula that shuts in Biemiller's Cove appears to be a wave built bar connecting the wider part toward the end with the land at the head of the cove. In the wide part the clay must be near the surface; at least I have found it near the surface at several points in the bay not far away and inside the cove a short distance from it.

The terminal portion of this peninsula has been built up by the bay in recent years; it appears to have extended about 18 rods in 1904 and double that amount since the survey made by the War Department in 1872. In the survey of 1826, however,

it extended a quarter of a mile farther than in 1872. (See Map I.) A map "60 years old" representing Cedar Point as divided into city lots shows two islands off the end of this peninsula and in line with it, named Big Sandy Island and Little Sandy Island. The water is still very shallow there.

The chart of 1826 shows the cove narrower and the land both sides of it much wider than now. Part of what appears on the chart as land must have been marsh. These changes have been produced mainly by the rising of the water but on the bay side of the peninsula land has been cut away by the waves. A number of trees were overturned in 1904. People remember seeing the same thing years ago along the lake shore not very far from the laboratory, and a chart issued in 1864 marks this shore "wearing away."

THE DUNES.

Irregularities of the original surface and the existence of trees and bushes have caused the wind to build up numercus sand dunes, the highest of which according to Kellerman is 27 feet. The other parts of Cedar Point having been built up anew are much more regular.

The sand which here has been heaped into dunes and the sand which in the terminal portion of the peninsula has been piled into ridges is ffom two sources.

(1st) It has been transported along the beach from Rye Beach and beyond, most of the pebbles, having been reduced to sand while in transit. Sticks tossed into the lake usually drift toward the northwest, though sometimes in the opposite direction. The movement of sand and other things along the beach is almost always toward the northwest for its motion is accomplished by the combined action of waves and shore current, the waves lifting the materials and the current carrying them forward. Waves on this shore are raised by an east wind and the accompanying shore current I believe is always toward the northwest. The crest of the wave is oblique to the shore and its left strikes first causing the water to rush along shore toward the right carrying the sand with it while the portion of the sand carried lakeward by the undertow is moved by the shore current in the same direction as that on the beach.

(2d) Sand swept out of the mouth of the bay by the rapid current is carried ashore on Cedar Point, some of it probably going nearly or quite to the Carrying Ground. Recently my attention was called to the existence of such an eddy by Lorenzo Anthony who long ago used to set fish nets east of Cedar Point. I recalled that a certain bottle which I had set adrift in the bay

was found broken and among timbers at or near the Carrying Ground. This was Bottle No. 37A, dropped half way between Sandusky and the west end of Johnson's Island at I P. M., Sept. 26, 1902, and carried by the current into the lake and cast ashore nearly 3 miles from the lighthouse, where it was found the next morning at nine o'clock. Bottle 42A set adrift at the entrance to the bay went ashore on the lake side of Cedar Point about half mile from the lighthouse. Both of these must have gone out beyond the end of the jetty. A number of my bottles were dashed to pieces on the jetty. After Mr. Anthony told me of his observation, I had a bottle thrown in the lake beyond the end of the jetty; Captain Magle reported that he threw it near the can buoy. This was about 3 P. M., Dec. 3, 1904. Dec. 6, at 8:30 A. M., a man who had crossed the bay on the recently formed ice found the bottle on the lake beach more than two miles from the lighthouse.

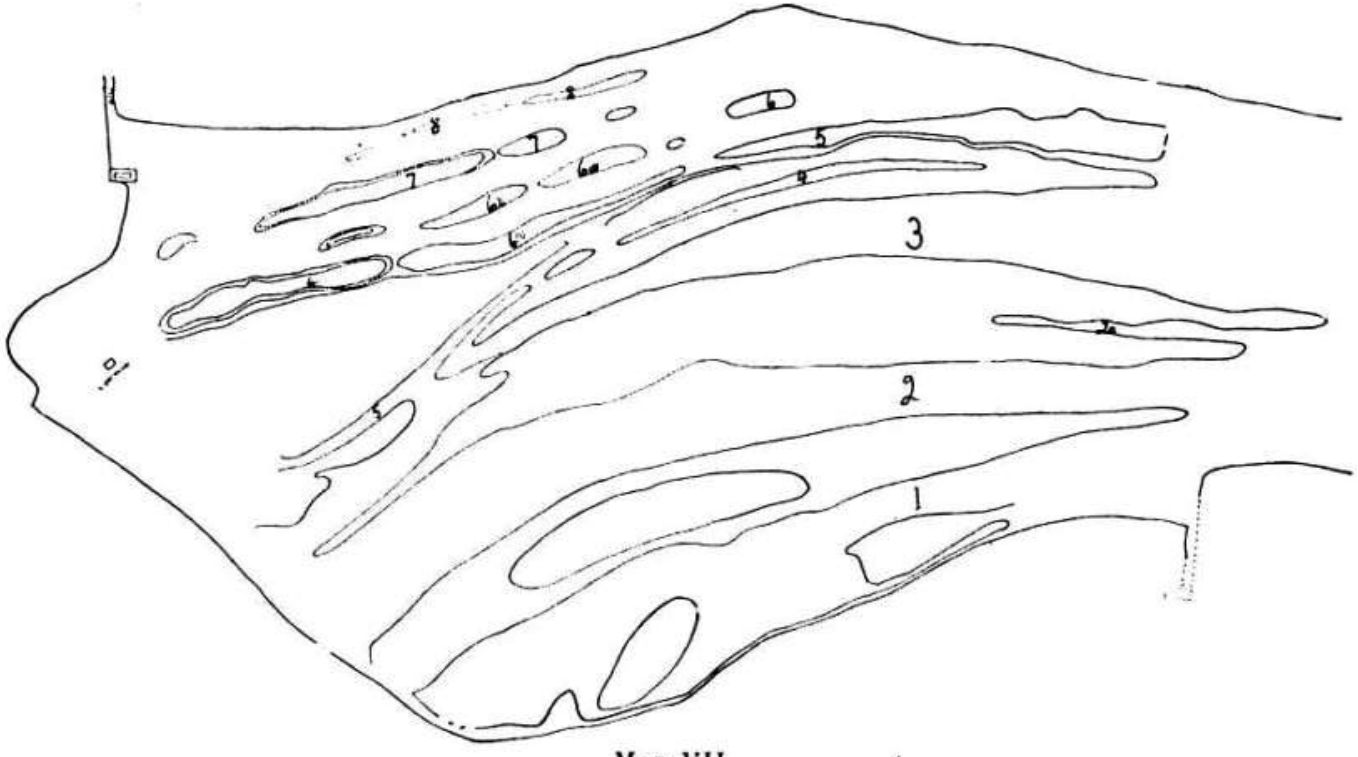
Part of the sand brought ashore by such a current may have come originally from the vicinity of Huron, having travelled the whole length of the beach, in and out of the bay a number of times and then ashore on Cedar Point again some where between the Carrying Ground and lighthouse perhaps to be pushed along to the end again and go the rounds once more. It would be interesting to know how many times some of the grains have taken such a journey. Another part of the sand which is swept out of the bay originated at Marblehead. This of course becomes mingled with that from the southeast.

The wider beach along this part of the peninsula gives the wind more opportunity to take up sand, while its fineness caused by long attrition favors its transportation by the wind.

RIDGE SECTION OF CEDAR POINT.

This is the terminal portion of the peninsula, extending from the end to Biemiller's Cove, about one mile. Its maximum width is over half a mile when the water is low but less when it is high. It is made up of parallel ridges which have been built up by the lake and consist of beach gravel and sand. It contains no clay or rock near the surface. At the power house clay was found about 23 feet below lake level and rock 46 feet below. Farther north both are probably deeper still.

In crossing this part of Cedar Point not very near either end eight ridges are easily distinguished. Towards the end, especially the south end, are others which do not extend so far. These eight ridges I have numbered beginning on the bay side. In describing them, however, I will begin with the most recent.



MAP VII.

Ridges of Cedar Point.	Contour line of
Ridge 1,	2 feet above Lake Erie.
" 2,	2 " " " "
" 3, s-w side,	2 " " " "
" 3, n-e side,	4 " " " "
" 4,	4 " " " "
" 5, n-w part	2 " " " "
" 5, s-e part	8 " " " "
" 6,	8 and 10 " " " "
" 7,	8 and 10 " " " "
" 8,	4 " " " "

The ridges are not interrupted but in places descend a little below these levels so that these contour lines make them seem broken.

RECENT RIDGES.

Ridge 8 extends along the lake to within 36½ rods of the Beacon Light at the inner end of the jetty. It is only three or four feet higher than the valley behind it, but is growing. Its crest is well covered with cottonwoods whose lower branches are partly buried in the sand and whose tops rise only eight feet above it. Several of these cut with a jack knife showed five rings. It has evidently formed since the jetty was begun, Oct., 1896, and probably because of the accumulation of sand produced by that obstruction. At the north end is a group of cottonwoods 11 to 14 feet tall. These may have been a factor in determining its location. Besides cottonwoods Ridge 8 has a number of small willows, but no other trees.

In the valley behind Ridge 8, is a conspicuous line of driftwood and many fragments of coal from wrecks marking the place where the waves came before this ridge was formed.

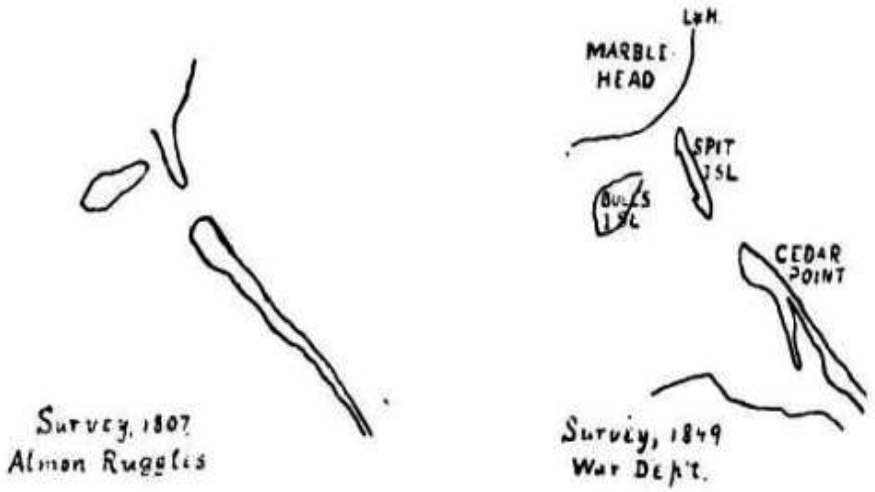
Ridge 7 is longer, broader and higher, rising 12 to 16 feet above the lake. Its crest is covered with cottonwoods 35–50 feet tall growing almost to the exclusion of other trees. In one spot are several buttonwoods 12–17 inches in circumference. There is a willow (Salix amygdaloides) 17 inches in circumference quite a number of white ash, the tallest 6 feet, an oak and a maple less than 2 feet. Two cottonwoods were found with a circumference of 37 inches. One of them 52 feet tall was cut three feet from the ground and 21 rings counted. As the section was 3½ feet above the roots and the inner circle thick, three or four years may be added in estimating the age, making it 24 or 25 years. Ridge 7 has no trees much older than this. It probably originated in 1878 the year of maximum rainfall at Cleveland and Buffalo. This is the year in which a ridge was formed on the Marblehead Sand Spit on the other side of the entrance to Sandusky Bay from Cedar Point according to a fisherman who lived there. On September 11, 1878, occurred the great storm described in the first chapter. No doubt this or the storm of August 15, 1879, probably both, were instrumental in the building of this high ridge. Cottonwoods started on it in 1880 and were not all destroyed by the great storm of April 23, 1882, but their roots more deeply covered. The ridge was then finished so far as the work of the waves was concerned.

In the valley behind ridge 7 and resting upon the base of ridge 6 is a line of driftwood, some of it rotten. In it were found a cleat of a boat and a large cinder or clinker. There are also shells of clams and other mollusca that live in the lake. Shells and coal were found both on and below the surface, a fish bone below the surface.

Ridge 6 resembles ridge 7 in breadth, height, and vegetation but the trees are larger. Its southern portion is single but toward the north are two ridges of about the same age which I have designated 6 (1) and 6 (2), the former being the highest of all the ridges, in one place nineteen feet. These will be included in any reference to Ridge 6. Here too cottonwoods predominate over all else. One locust (Robinia pseudacacia) is 37 inches in circumference and about 62 feet tall. White ash is perhaps ten times as numerous as on Ridge 7, the tallest about 18 feet, but most of them less than 12 feet. There are several cedars 10 feet or less in height and a very few trees of other kinds. Most of the cottonwoods are not much more than a foot in diameter but two were found 55 inches in circumference One of these near the big locust was cut and found to have been 64 feet tall and to have 41 or 42 rings about 3 feet above the roots, indicating an age of about 44 years. This Ridge was doubtless formed at the time of the high water 1858–62, probably by the same storms that swept the trees from the bar and moved the bar over onto the marsh. The oldest trees on the bar appear to be of about the same age as those on Ridge 6. In the valley between 6 (1) and 6 (2) we found clam shells, decayed driftwood and peat such as one finds on the present shore. A few inches below the surface in a thin layer of organic particles such as one finds at the margin of littoral pools we found pieces of coal and cinders. As late as 1866 steamers entering Sandusky Bay with coal smoke issuing from their funnels attracted some attention, for most of the steamers burned wood. This shows that Ridge 6 (2) which must have been formed after the coal and cinders had been washed ashore is not much older than 1859. Ridge 6 (1) may have started in 1857 or 1858 and have been completed in 1859 while Ridge 6 (2) may have been built by the great storms of 1861 and 1862. This part of Cedar Point was surveyed for the War Department by Lieutenant Colonel Graham in 1862. The shore line shown on his chart is farther northeast than it was in 1849 when the last survey previous to 1862 was made. In a map illustrating a report on Sandusky Harbor by Colonel T. J. Cram, U. S. Engineer, 1864, taken partly from Graham's survey in 1862 the northeast shore of what I have called the dune section of Cedar Point is marked "wearing away." Doubtless much of the sand removed from that section was built into these ridges. Besides, sand derived from dunes lately demolished on the other side of the channel after being swept into and out of the bay must have found a resting place here.

Before proceeding to consider the age of the older ridges it may be well to draw some further inferences regarding these that

were formed in the 19th century. The mode of formation is probably as follows: A great northeast storm occurring at a time of high water piles up the sand to a height which is beyond the reach of the ordinary storm or a great storm occurring when the water is not above its ordinary level. In the spring numerous seeds from the cottonwoods that grow in such profusion on the ridges farther west are wafted by the wind to the newly formed ridge or possibly cast upon it by the waves, after falling into the lake. Here they have sufficient moisture, yet the roots are never below water level. As they grow they help to hold the sand that is blown by the wind and other sand that may be tossed up by the waves of other great storms, so that their roots are soon deeply buried. The willows too send their seeds in good season to take possession of the new land but they cannot muster so



MAP VIII.

large a force as the cottonwoods and being unable to grow as fast are left in the shade, while the sand accumulates so fast that they cannot keep their heads above it. After the ridge reaches its full height seeds lodging on its surface cannot get moisture enough. So the cottonwoods are left in undisputed possession. When they have grown so large that birds frequent them or roost in their branches the seeds of poison ivy and other vines are dropped and germinate. The dead leaves begin to accumulate over the sand and form a mulch. A few herbs spring up and help the vines to keep the dead leaves on the ridge. The wind brings keys of the white ash and birds drop seeds of red cedar and some of these find moisture enough to enable them to grow.

CEDAR STUMPS.

In determining the age of most of the older ridges I have depended on data furnished by cedar stumps. Several points must be considered. 1st. The ridge was formed probably nearly or quite 40 years before cedars started to grow on it. Ridges 8 and 7 have no cedars. Following ridge 6 a certain distance, Fred Lay counted 13 cedars, all quite small, and returning to the starting point along Ridge 5, he counted 160. On the bar, which has cottonwoods over 40 years old, are no cedars although it is nearly 5 miles long. On the Marblehead Spit which has formed northeast of Johnson's Island since 1858 the only cedar is one that is said to have been planted. 2d. The large cedars on Cedar Point were cut more than half a century ago. Mr. Samuel Catherman who came to Sandusky in 1835 says "right along after that cedars were cut on the Point; there was quite a business of cutting and transporting them to Sandusky, where all the fence posts were cedar and the frames of quite a number of houses, some of them still standing. The wood was used also for other things. Most of the largest ones had been cut by 1850 or about that time." Mr. Louis Adolph, who came in 1863, says, "they had been cut long before that." Captain Freyensee remembers that in 1849 or 1850 in a warm day in January he helped load a scow with cedar posts about half way between the present dock of the Cedar Point Company and the U. S. Government dock. The yawl used to carry the posts out to the scow was loaded so high that it turned over spilling the posts with him into the bay. He does not remember seeing cedar timber brought from Cedar Point after that. According to John Homegardner, Sr., and others the last of the large cedars were removed from Cedar Point by D. C. Richmond who used them for posts on his farm where they have remained sound to this day. This was in February, 1850. One of the men employed in the work was drowned. Mr. Homegardner too says, "they began taking them from the Point as early as 1835." Dan Myers came in 1852. He says "some cedars were cut in 1853 or '54. Probably these were not among the largest. 3rd. After counting the rings on a stump a number equal to five-eighths of the number of rings in the outer inch is added on account of the sap wood that has rotted away. 4th. The largest stumps are hollow and in estimating their age it is not right to assume that the number of rings to the inch in the missing portion was about the same as in the portion remaining. As a general rule the number to the inch increases toward the outside, though this is not very noticeable in small stumps;

in some of them the reverse is true. If the stump has a large hollow, estimates of its age are probably not very close. If the hollow is larger than in other stumps of similar size growing near, it is perhaps an indication not of greater age but of more rapid growth. If the stump is on low ground I think it is more likely to be hollow and Bartelle Reinheimer who has assisted in count-the rings has observed that stumps on low ground average fewer rings to the inch than those on higher ground. Doubtless the character of the wood and the abundant moisture both contribute to hasten decay. Many of the medium sized stumps are still nearly sound. For the first four inches from the center the number of rings averages about 13 or 14 to the inch and for the next four inches about 17 to the inch. Near the outside of one large stump 59 rings were counted in a single inch.

OLD RIDGES.

Ridge 5 back of the new hotel rises 13 feet above the lake, being higher than any of the ridges farther west. The theater, main pavilion and several other buildings stand upon it. Toward the northwest it diverges from Ridge 6 (1) giving room for a swamp containing a small pond. Although low in this part it is distinctly traceable to the vicinity of the lighthouse. Upon it is the rankest growth of poison ivy and other vines and an abundance of scouring rush and False Solomon's-seal. The cottonwoods have attained to old age and many other trees have grown to considerable size— black oak, white pine and basswood, more than 5 feet in circumference, white ash, red elm, sycamore and willow (Salix amygdaloides) more than 3 feet. Several of the cottonwoods exceed 8 feet in circumference. One measuring 111 inches was broken off probably by the wind, not less than 18 years ago according to Chas. Baetz. Where broken it is rotten but by chopping to the center of it 15 feet from the roots we were able to count about 141 rings. Allowing 10 years for the first 15 feet of growth we conclude that this tree started about 170 years ago. A few other cottonwoods are larger and were likely larger when this ceased growing. The living cedars on this ridge do not exceed ten inches in diameter but there are a few stumps a foot in diameter. On one of these 85 rings were counted. Another a little larger was not in such condition that the rings could be counted. It was probably but little older. Adding 90 to the number of rings counted for reasons given in a preceding paragraph we conclude from this cedar stump that Ridge 5 is not much less than 175 years old. It is likely older but probably not 200 years. We will take 180 years as its approximate age.

Ridge 4 is not very distinct from Ridge 3 toward either end but throughout the remainder of its length well defined, though rising only four or five feet above the valley on either side and only about four rods wide. It may be easily found by going west from the new hotel, "The Breakers," across Ridge 5, which is much higher. Its cedar stumps are but little larger and older than those on ridge 5. I estimate its age as 220 years.

Ridge 3 is ten or twelve rods broad and has an undulating surface. The power house and a number of other buildings stand upon its southern portion. In places it looks as if formed of two parallel ridges so close together as to be distinguished with difficulty. It has a rich vegetation—herbs of great variety and large trees of many kinds. It has ten cedar stumps 20 inches or more in diameter, three or four of them being about two feet. The age of the older ones has been estimated at 163, 165, 194, and two, less carefully determined, about 210 years each. Ridge 3 is probably about 310 years old.

Ridge 2 is situated between the two lagoons. It has large trees of various kinds, including black cherry which would not start until the soil had become enriched. It has many cedar stumps about 20 inches in diameter and two that exceed two feet. On one of these 26 x 27 inches, I counted 189 rings in the outer ten inches. Nearer the center of growth indicated by a knot, most of the wood has disappeared but some chips showed 8-16 rings to the inch. Allowing 13 rings to the inch the remaining 4 inches would add 52 rings, the sap wood 15, making a total of 256. On account of its size and location it was probably among the earlier cedars to be cut. Adding 65 years for this and 40 for time elapsing after formation of ridge before this tree started we have a minimum age for Ridge 2 of 361 years, but it is older than that. Ridge 2A, low and narrow, lies to the northeast of Ridge 2 and terminates about one-sixth of a mile from the cement walk. It has two stumps larger than any on ridge 2. One of them, 37 x 37 inches is probably the oldest stump on Cedar Point. When discovered, Oct. 22, 1904, I estimated the age as about 300 years. Feb. 19, 1905, I visited it again and made a more careful estimate. I found about 80 rings in the outer 3½ inches, the remaining portion being too much decayed to admit of counting many consecutive rings. The average of four fragments taken from different parts of the decayed portion was 13½ rings to the inch. This with 15 years for sap wood gives an age of 297 years. Ridge 2A, therefore, cannot be much less than four hundred years old, and as it was formed after Ridge 2, we will call the age of Ridge 2 four hundred years.

Ridge 1, on which the "White House" is located has many

large black oak, American elm and other trees. Its cedar stumps are evidently older than those on Ridge 2, being larger and more decayed. Eight or more exceed 27 inches in diameter and four range from 30 to 36 inches. The ages of eight of the older ones were estimated at 185, 200, 220, 229, 236, 245, 261 and 262 years. The oldest, then, are but little older than the oldest on Ridge 2, and not so old as the oldest on Ridge 2A. It does not follow, however, that the ridge is only a few years older than Ridge 2 and 2A. In a forest that has been standing for centuries one is likely to find on five acres of ground one or two trees much older than any others of the same kind. Out of a hundred cedars starting at about the same time few live to be two centuries and ordinarily not one to be three centuries old. So the three-century cedar on Ridge 2A must be regarded as one that was exceptionally favored. The ten or twelve largest stumps on Ridge 1 appear to average fully six inches greater in diameter than the ten or twelve largest of Ridge 2. As these large stumps have an average of about 25 rings to the inch in the outer part we may take their average age as 75 years greater. The percentage of cedars to attain a diameter of 27 inches must be much less than of those that attain a diameter of 20 inches. It is therefore not improbable that Ridge 1 exceeds Ridge 2 in age by more than 75 years.

Number of Ridge	Name of Ridge	Estimated Age, Years.	Probable Error, Years.	Approximate Date of Formation.
1	Oak.....	475	50	1429
2	Cherry.....	400	25	1504
3	Cedar.....	310	35	1594
4	Pine.....	220	20	1684
5	Poplar.....	180	15	1724
6	Locust.....	45	2	1859
7	Buttonwood.....	26	2	1878
8	Willow.....	5	1	1899

BLACK SOIL.

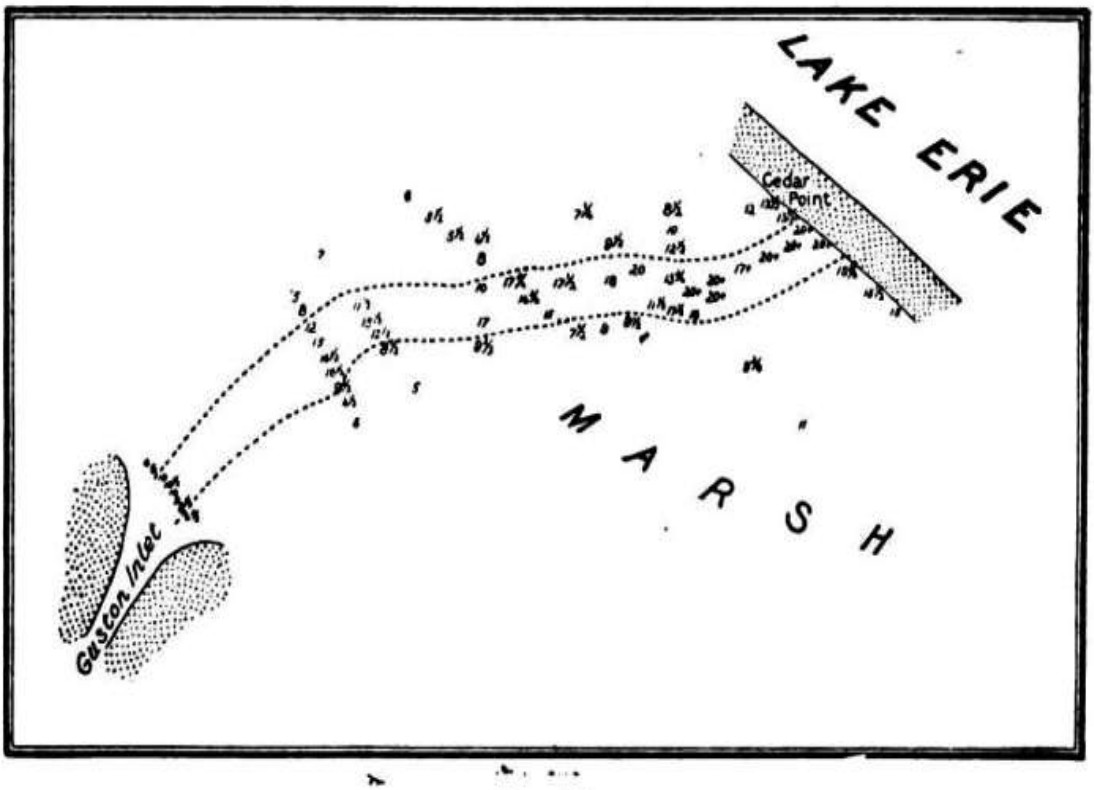
As we pass from the new to the old ridges, we notice a difference in the quantity of leaf mould that has accumulated. Ridges 8 and 7 have no covering of black soil. Ridge 6 has a little in places. On Ridge 5 it is about an inch deep, on Ridge 4, two inches, and on Ridges 3, 2, and 1, two to four inches or more. On Ridge 1 it is quite uneven, due, no doubt, to this ridge being so much exposed to the wind. The roots of many of its cedar stumps are well covered with sand.

HEIGHTS OF VALLEYS AND OF AQUEOUS DEPOSITS IN RIDGES.

Soon after I began studying the ridges I noticed in going from the bay toward the lake a progression in the height of the valleys between them. In periods of high water the valley between ridges 1 and 2 could be traversed for quite a distance with a row boat and in very high water such as that of 1858 with larger boats. At such times it connected with the bay at its northwest end. This has been open once at least in the last 25 years. In October, 1904, it was opened by the dredge which made the lagoon in this valley and cutting through Ridge 2 made a lagoon between Ridges 2 and 3. Here also was water though not quite so deep as in the first valley. Between Ridges 3 and 4, and between 4 and 5, grow the swamp rose, cornel, and blue-joint grass showing that the soil is damp. Until 1904 I had never seen water standing in these valleys. All through the nineties the lake was too low but in 1904 a little water was visible at the surface between Ridges 3 and 5 beyond the northwest end of Ridge 4 and extending quite a distance. Between Ridge 5 and the lake the valleys are so high above water level that the sand is too dry for most plants and the scanty vegetation reminds one of the barren zone of the bar.

When I found that the ridges had been built up successively by the lake and that considerable time had elapsed between the formation of the earlier and later ones, it seemed likely that each valley might be higher than its predecessors because the lake itself had become higher than when the earlier valleys were formed. This hypothesis was strengthened when it was found that the valley behind Ridge 6, which was formed by the very high water that prevailed for some years prior to 1863, was higher than the valley behind Ridge 7, which was formed about 1878, and this higher than the valley behind Ridge 8, which was formed at a time of relatively low water.

Having noticed a progression in the heights of the valleys, it seemed possible that the aqueous deposits in the ridges them-



MAP IX.

East and west section one mile long, north of the western part of Sandusky, intersecting the submerged valley of Mill Creek.

Valley extending under marsh from Guston Inlet to Cedar Point, about a mile and a quarter. Thirty-three borings within the lines all show a greater depth to clay than the nearest ones outside.

selves might also ascend from the bay toward the lake. So the ridges were dug into in about 150 places altogether with a view to finding the highest trace of water action in each. The accompanying table gives the result, the data being reduced to mean lake level.

HEIGHTS OF PRINCIPAL RIDGES AND OF VALLEYS SOUTHWEST OF THEM.

Number of Ridge.	Approximate height of valley southwest of ridge, feet.	Highest aqueous deposits found	Height of aqueous deposits above valley.
1		2 .66	
2	-3.	4.55	7.55
3	-2.5	5.4	7.9
5	1.5	9.4	7.9
6	4.5	12.13	7.63
7	3.3	11.35	8.05

DEEPENING OF LAKE ERIE.

As each of the principal ridges was formed by a great northeast storm occurring at a time of high water the progression in level from the older to the higher is due to an elevation of the level of Lake Erie compared with the land. The approximate rate of change is determined by dividing the difference between the heights of the aqueous deposits in any two of them by the number of centuries intervening between their formation. Each ridge higher than all those to the southwest of it was probably formed by one of the greatest if not the greatest storm of the century or one that was more potent than others because of the high water at the time of its occurrence. That they were formed under similar conditions is evidenced by the fact that in each the highest indication of water action is about 7½ or 8 feet higher than the valley behind it. The accompanying table shows the rate of subsidence based on a comparison of the older ridges with Ridge 6, the highest. Ridge 3 gives a rate considerably higher than the others. It may be that it was not formed at the time of the highest water that occurred for many years, though at a time of high water. If we compare it with Ridge 7

we get a rate of 2.1 feet per century, which closely approximates the rate obtained by comparing the others with Ridge 6. It is quite possible that Ridge 3 is older than I have estimated.

On some of the recent ridges are aqueous deposits at a higher level than that at which the main roots join the trunks of the trees, indicating that the ridge was not the work of a single storm. If these deposits were left long after the trees started they would vitiate the results shown in the table. I have found no evidence that they were left long after and in the case of Ridges 2 and 6, it is certain that they were not, because new ridges were soon formed in front of each. The percentage of probable error in the determination of the age of Ridge 2 is less than in the other old ridges. It is old enough to give a long time interval. The rate based on comparing it with Ridge 6 is near the mean of the rates based on other comparisons. For several reasons then it may be regarded as the best.

RATE OF SUBSIDENCE OF THE LAND BASED ON A COMPARISON OF HEIGHTS AND AGES OF OLDER RIDGES WITH RIDGE 6.

Number of Ridge	Maximum h'ght of aqueous deposits, feet	Approximate age, 1904	Older than Ridge 6	Lower than Ridge 6	Change of level feet per century
1	2.66	475	430	9.47	2.20
2	4.55	400	355	7.58	2.14
3	5.4	310	265	6.73	2.54
5	9.4	180	135	2.73	2.02
6	12.13	45			

The scarcity of gravel in all the later ridges and the valleys between them is in marked contrast to its abundance in and between the older ones. Ridge 4 and those more recent contain but little gravel; ridges 6, 7 and 8, probably not a hundredth part as much as ridges 1 and 2. It is scarce also along the present lake beach, but on the bay shore the old gravel deposits have been exposed by recent erosion. When the older ridges were formed the hardpan overlying the rocks of the Dune Section and containing an abundance of pebbles and boulders was in reach of the waves; but when the later ones were formed the lake had attained a higher level and the hardpan was too far below the

surface to furnish more material. Most of the sand in the recent ridges and present beach has either been transported many miles from the southeast or carried by currents at the mouth of the bay.

The extension of Cedar Point lakeward and the formation of so many ridges in the last half century is probably due to the washing away of Peninsula Point on the other side of the entrance to the bay, the material being derived largely from that source.

Surveys show the width of Cedar Point from Rosebush Point to the lake to have been about 2350 feet in 1896, about the same in 1872, and about 2340 feet in 1826. If these measurements are correct the bay has worn away about as fast as the lake has built up. The jetty begun in 1896 and not completed for several years has already caused the accumulation of many acres of sand.

CONCLUSION.

LOOKING BACKWARD.

The broad and shallow rock valley occupied by Sandusky Bay was formed partly by preglacial, partly by glacial erosion. Upon the retreat of the glacier the greater part of this valley was filled with glacial clay nearly or quite to the present water level.

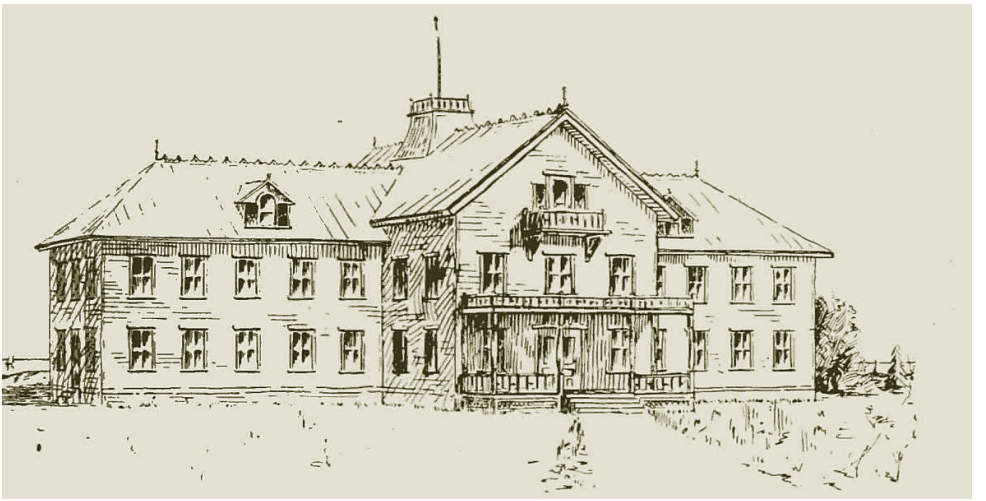
When the melting of the ice made an outlet to the east for the glacial lake, Lake Erie was established. At first it occupied only the eastern part of the basin it now occupies. The Sandusky River then flowed much farther than now, cutting a valley in the clay. Its tributaries also made valleys. The depression of the west end of the Erie basin relative to the point of outlet caused the lake to extend westward In time slack water extended up the valley of Sandusky River as far as the present entrance to Sandusky Bay. The depression of the land continuing, marshes were formed along the river and its tributaries and after a time the water southeast of Johnson's Island had become so deep and wide that the waves cut away the clay between the valleys. The bay thus started was enlarged both by the rising of the water and by wave action, the latter proceeding more rapidly as the enlargement went on.

The rising of the water has continued with a nearly or quite uniform rate—about two and one-seventh feet a century—for at least four centuries. If the rate was about the same during the preceding centuries we may conclude that at the beginning of the Christian Era slack water extended up the Sandusky River valley as far as Johnson's Island. Fifteen hundred years ago it extended up the valley of Mill Creek about a mile and a half from

been reached by the rising water, the whole of Cedar Point may share the fate of Peninsula Point at no distant date unless jetties, piers, cribwork, etc., suffice to save it.

The bay with the connected marshes is probably twenty per cent larger now than in 1820. So far as the enlargement is due to erosion it should proceed more rapidly the wider the bay becomes, for the waves attain greater force. The effect of the waves, however, is diminished by the bay bridge, by jetties at the entrance to the bay, by docks and by stones put on the shore purposely to protect the land. The enlargement of the bay due to the subsidence of the land may be partly prevented by dikes and may be effected to some extent by changes at Niagara Falls produced by human agency. We may reasonably expect, however, that the bay will continue to spread over the adjacent lowland much as it has been doing for centuries past.

The rise of the water due to tilting of the land, 2.14 feet in a century, is about the same as the change of lake level that sometimes occurs within a year in consequence of variations in the rainfall and is considerably less than that produced in Sandusky Bay by a single northeast gale. It is, however, cumulative. The present generation is likely to see the water higher than it was in 1858 and in northeast gales the lower parts of Sandusky submerged, but at the present rate of subsidence the bay at ordinary stages of the water will not extend up Columbus Avenue as far as Market Street for about eight hundred years. Port Clinton is not so fortunately situated. Northeast gales will cause much trouble there as soon as there comes a period of several years when the rainfall is considerably above normal, and before the middle of the next century the water at such times will go quite across the peninsula from Port Clinton to Sandusky Bay. After two or two and a half centuries the water will cover this part of the peninsula for months at a time and after three centuries will do so at ordinary stages. Marblehead will then be an island and Sandusky Bay will show no resemblance to its present form.



Too Much Progress for Old 'Lab' At Cedar Point, Now to Be Torn Down; Biologist's Paradise Gone

(From *Ohio State University Monthly*)

FOR two years the Lake Laboratory building at Cedar Point has been unoccupied and, as there is no probability that it will be used again, the trustees of the University have authorized its demolition.

This does not mean that the Lake Laboratory has ceased to exist, but that it has been removed to another and, as conditions now stand, more suitable location.

To say that civilization has rendered the wilderness uninhabitable sounds like a paradox, but such is the truth in the case of Cedar Point as far as the old Lake Lab is concerned.

When the laboratory was first established in 1896 and when this building was erected in 1903, the long stretch of sand dunes on Cedar Point reaching from the resort nearly to Port Huron was entirely uninhabited. This, in connection with the thousands of acres of marsh forming the east end of Sandusky Bay, made a veritable biologist's paradise no longer than 15 years ago.

Then the unexpected happened, according to its established custom, and Cedar Point was exploited as a summer resort.

A macadamized road was constructed the whole length of the sand dunes, automobiles whizzed along where only the terns and dragonflies were wont to course and gasoline fumes became mingled with the odor of the marshes. The sandy waste was cut up into building lots and summer cottages sprang up like mushrooms around the laboratory site; a large hotel was built; so-called amusement places multiplied apparently over night, and a noisome sewer was run into the bay near the laboratory. The Point became popular and populous.

By the summer of 1917 this multiplicity of evils, to the mind of the biologist on investigation bent, had rendered the situation unbearable and, greatly to the regret of all, it became necessary to seek another location.

A bit of the history of the Lake Laboratory may not be amiss here. The idea of establishing a place for summer work on Sandusky Bay apparently arose first in the mind of Professor D. S. Kellicott, at that time Head of the Department of Zoology and Entomology, and in 1895 arrangements were made with the State Fish and Game Commission for the use of space in the State Fish Hatchery, then situated near the waterworks in Sandusky.

In 1902 the number of students had increased to such an extent that other quarters were necessary and in 1903 the building on Cedar Point was opened. Professor Herbert Osborn had become director after the death of Professor Kellicott in 1898 and to him belongs the credit of selecting the Cedar Point site on Beimiller's Cove, a place admirably suited for the purpose, had conditions only remained unchanged.

For fifteen years the building was regularly used by as many students as could be accommodated, advanced courses in various biological subjects were offered, investigation was encouraged. During this time more than fifty scientific papers, some of them of considerable importance, were published as a result of studies pursued within its walls and bearing on the rich and varied life of the dunes and marshes. What is even more important, many students, some of whom are now well known for their researches, received here their first introduction to biological investigation and to methods of attacking problems in the field.

This annotated (2021) version of E.L. Mosely's *'Formation of Sandusky Bay and Cedar Point'* is freely available on the archive.org website.

[ALSO (as a "companion" to the above) SEE THE '1912' MAP OF CEDAR POINT (at archive.org)]

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